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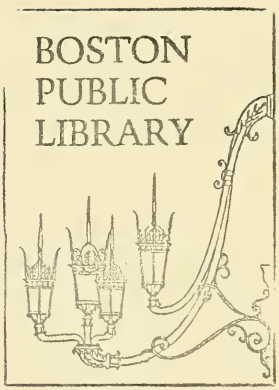
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Volume IV: Environmental Impacts

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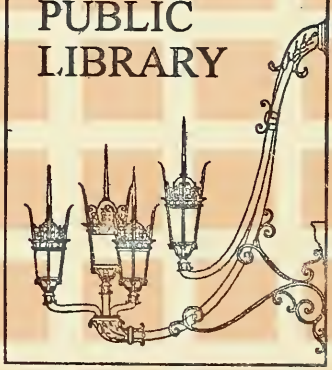
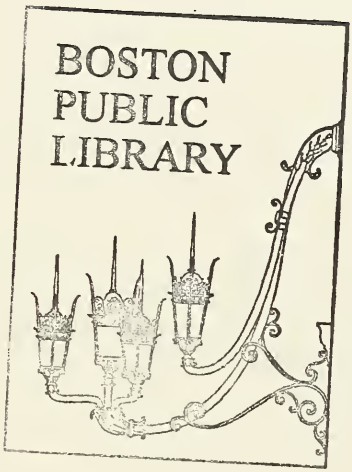


The Prudential Property Company, Inc.
for The Prudential Insurance Company of America

PRUDENTIAL CENTER REDEVELOPMENT

DRAFT PROJECT AND ENVIRONMENTAL IMPACT REPORT
Volume IV: Environmental Impacts

IV



April 12 1989

submitted to:
The Boston Redevelopment Authority
Massachusetts Executive Office of Environmental Affairs
Executive Office of Environmental Affairs Number: 7208

submitted by:
The Prudential Property Company, Inc.
for The Prudential Insurance Company of America

HMM Associates

DRAFT PROJECT AND ENVIRONMENTAL IMPACT REPORT

PROJECT

Prudential Center Redevelopment
Boston, Massachusetts

DEVELOPER

The Prudential Property Company, Inc., for The Prudential Insurance Company of America

STATUS OF PROJECT

The developer submitted a Project Notification Form to the Boston Redevelopment Authority (BRA) and an Environmental Notification Form to the Massachusetts Executive Office of Environmental Affairs (EOEA) on June 29, 1988. Scoping letters were issued to the developer by the BRA and EOEA on September 1, 1988. The EOEA number is 7208. The project is in pre-schematic design stage. Master plan approval is being sought.

BRIEF DESCRIPTION OF THE PROJECT

The project includes the addition of new offices, retail spaces and housing to the current Prudential Center site. New housing and offices, with retail uses at their base, will be constructed principally along the Boylston Street, Huntington Avenue and Belvidere Street frontages. The current retail area will be reconstructed and expanded with indoor pedestrian passageways. Enclosed pedestrian routes will provide connections between Boylston Street and Huntington Avenue, and between Copley Place and the south entrance of the Hynes Convention Center. A system of public squares, a wintergarden and outdoor open spaces will be created as amenities for those using the center and adjacent neighbors. A neighborhood commercial area, including an expanded supermarket, is proposed for Huntington Avenue and East Ring Road. East Ring Road will be improved to facilitate pedestrian flows to the shopping area. The existing parking garages will remain approximately the same size, but their capacity will be expanded by approximately 800 spaces through changes to their management.

ALTERNATIVES CONSIDERED

Two basic planning approaches have been considered for the site, and for each three scales of building program have been analyzed. Alternative A proposes two new office structures along Huntington and principally housing, with a small office structure, along Boylston. Alternative A2 has housing as well as offices along Huntington Avenue and housing, along with expanded offices, along Boylston Street. The form of structures, their heights, and the organization of pedestrian routes also vary between these two basic alternatives. Alternatives B and B2 are similar in configuration, respectively, to Alternatives A and A2, but the overall development totals 10 percent less area. Alternatives C and C2 follow the same outlines, but are 20 percent smaller in area than Alternatives A and A2. In the course of preparing these plans, a large number of other design and functional alternatives were considered and rejected as less desirable.

DEVELOPMENT PROGRAM

The three basic levels of program studied are, as follows:
(000 FAR gross sq. ft.)

Use	Alternatives A and A2	Alternatives B and B2	Alternatives C and C2
Offices	1,009	865	811
Residential	404	378	324
Retail	268*	210*	160*
Total Areas	**1,681**	**1,448**	**1,295**
Plus Indoor Pedestrian Areas	153**	153**	103**
TOTAL PROGRAM	**1,834**	**1,601**	**1,398**

* In addition, 143,000 gross sq. ft. of existing retail is demolished and rebuilt.

** Areas vary slightly between alternatives.

DEVELOPMENT SCHEDULE

The project is planned as a number of separate phases to be completed over a 10 year period. Construction will begin on the south side of the site, moving to the north. Phases along Huntington Avenue should be completed by 1994, with the Boylston Street area completed by 1999.

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IA: Summary Appendix
II: Urban Design Alternatives
III: Transportation Access Plan
IIIA: Transportation Access Plan Appendix
IV: Environmental Impacts
V: Wind Impacts
VA: Wind Impacts Appendix
VI: Infrastructure Systems
VII: Housing Impacts
VIII: Public Benefits
D: Drawing Set

PRUDENTIAL CENTER REDEVELOPMENT
DRAFT PROJECT IMPACT REPORT/ENVIRONMENTAL IMPACT REPORT
VOLUME IV: ENVIRONMENTAL IMPACTS

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1.0 SHADOWS

1.1 Scope of Study

This chapter presents the results of the shadow study conducted for the proposed project. Horizontal shadow profiles were compiled to depict the extent of additional shadows associated with the new buildings of the Prudential Center Redevelopment project.

Shadows for each season were studied as follows for Alternatives A and A2: summer solstice (June 22); vernal equinox (March 21); autumnal equinox (September 23); and winter solstice shadow (December 22). For each of these times of year, representative morning (9:00 AM), noon (12:00 PM), and afternoon (3:00 PM) shadow patterns were calculated and plotted. Additional shadow analyses were conducted for 10:00 AM, 11:00 AM, 12:00 Noon, 1:00 PM, and 2:00 PM on October 21 and November 21 to define sunlight conditions in the later fall (and early spring) when sunlight can extend the use of outdoor spaces. For Alternatives B, B2, C, and C2, shadow studies were compiled for the vernal equinox (March 21) and autumnal equinox (September 23) at 2:00 PM.

Fifty-two figures, Figures IVA-1 through IVA-52 (presented in Appendix A), show the horizontal shadow profiles for each Alternative. The diagrams show existing shadows indicated by a dark dot pattern. Additional shadows created by the introduction of the redevelopment project's new buildings are indicated by a light dot pattern. The net new shadow is the measure of the project's shadow impact, indicating areas where new shadows fall on previously sunny places.

1.2 Analysis of Results

The objective of the extensive shadow study performed for the Prudential Center Redevelopment is to understand how existing and future shadows, under each alternative, will affect areas that are shadow sensitive. These include outdoor open areas and plazas where people congregate, outdoor children's play areas, and, to a lesser extent, sidewalks where pedestrians may enjoy sunshine as they walk.

The shadow diagrams prepared for this project have been analyzed to determine shadow impacts on the following sensitive areas, both in and around the Prudential Center:

1) Christian Science Plaza.
2) Huntington Avenue and Belvidere Street sidewalks and Plaza.
3) South Plaza, south of the Prudential Tower.
4) Residential Court, including a children's play area, between the Fairfield, the Boylston and new residential structures.
5) Gloucester Court, between the Gloucester and Lord & Taylor store, including a children's play area.
6) Boylston Plaza, in front of the Boylston Office building and Boylston Street pedestrian areas.

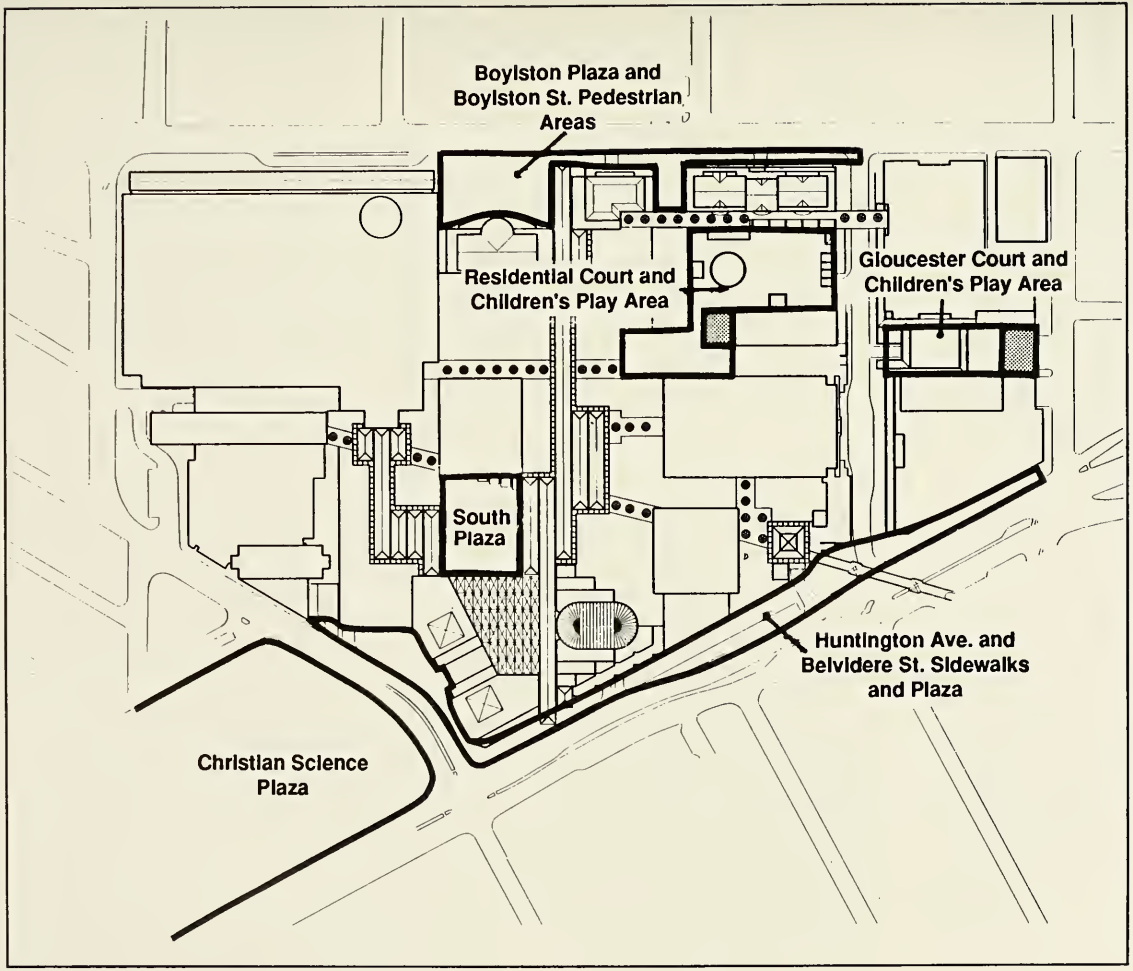
The sensitive areas are shown on Figure IV-1. Shadow conditions in each of these areas are discussed below.

1) Christian Science Plaza

The Christian Science Plaza is almost directly west of the southernmost tip of the Prudential Center, and south of most of the Prudential Center. Thus, there is limited potential for shadow impacts.

Under existing conditions, shadows from the Prudential Center do not fall on the Christian Science Plaza at any time of the day or year. Similarly, no impacts result from the project at any time studied. Under Alternative A, shadows from the Belvidere Office building at 9:00 AM on June 22 fall partially across Belvidere Street but do not reach the Plaza, and as the day progresses, the shadows swing away from the Plaza onto the Prudential Center. At all other times examined, shadows do not fall to the south, toward the Plaza, at all.

Similarly, there are no shadow impacts associated with any of the project alternatives.



Prudential Center Redevelopment

Fig. IV-1
Shadow Sensitive Area

Children's Play Area

0 100 200
Scale : feet

2) Huntington Avenue and Belvidere Street Sidewalks and Plaza

The potential for shadow impacts on Belvidere Street and Plaza exist during the early morning when shadows fall to the west. Impacts may occur on Huntington Avenue late in the day when shadows have shifted around to the east.

Under existing conditions, no significant shadows fall along these areas since no buildings are located in the triangular area at the southern tip of the site. Under Alternative A, shadows from the Belvidere Office building fall on the Plaza during the early mornings in summer only, and are gone well before noon. This is similar under all alternatives.

The pedestrian areas along Huntington Avenue are not affected until the afternoon. The Huntington Office building casts a shadow on the Huntington Avenue sidewalk adjacent to the Turnpike off-ramp at 3:00 PM during the summer (June 22) under each alternative analyzed. This impact is more pronounced in the spring (March 21), but does not occur (until perhaps much later in the afternoon) during the fall periods studied. This is due to daylight savings. Again, all alternatives have similar shadow impacts on this area.

3) South Plaza

The South Plaza is a major outdoor open space planned as part of the redevelopment project. It lies to the south of the Prudential Tower, but has a northerly orientation relative to the two structures planned for Belvidere Street and Huntington Avenue. As a result, it is affected by shadows from these buildings.

Under Alternative A, summer shadows from the Huntington Office building fall on the South Plaza in the morning hours, and shadows from the Belvidere Office building occur at noon. Noon shadows are short, and affect approximately one-half of the Plaza. This affords a choice of sun or shade to users of this area on a hot summer day. By 3:00 PM, the Plaza is in full sunlight. During the spring and fall equinox study periods, the Plaza is

largely in shade from the Huntington Office building at 9:00 AM. By noon, it has significant amounts of sunlight, a result of the setback of the Belvidere Office building from the Plaza. At 3:00 PM, shadows from the Sheraton Hotel as well as the Belvidere Office building affect it, but the separation between the two buildings leave the plaza in partial (up to half) sunight still. During the winter (December 22), little sunlight reaches the South Plaza until afternoon.

More detailed studies of the later fall (October 21, November 21) for Alternative A reveal that the Plaza is in partial shadow and partial sunlight at almost all times studied (10:00 AM, 11:00 AM, 12:00 Noon, 1:00 PM, 2:00 PM). Sunny spots vary as the sun moves and shadows from different buildings affect the Plaza.

Under Alternative A2, the Belvidere Office building is replaced with a lower residential building, and the Huntington Office building is taller and closer to the South Plaza. The result of this configuration is that, at some times, when shadows from the Belvidere Office building dominate the Plaza, shadows are less. These times are generally noon and later times in the day. However, at times when the Huntington Office building dominates, during the morning, shadows are increased. Under Alternatives B, B2, C, and C2, during the study times, impacts on the South Plaza are not significantly different from the A Alternatives.

4) Residential Court

The Residential Court lies to the north of the Boylston apartment building, to the east of the Fairfield apartment building, and south of the proposed new residential structure on Boylston Street. It includes a children's play area located at the western end of the existing Boylston building. Since the new building construction lies to the north of the Residential Court, it has no shadow impact on it at any time during the year. This is true for all alternatives.

The Residential Court is affected by shadows from all three of the existing residential buildings, as well as the Prudential Tower. During the summer, the Court is in partial shadow. At noon, shadows are short and affect less area. It may be an advantage to have some sunny and some shady areas to provide a choice for users of the Court on a hot summer day. During the fall and spring, much of the Court is in shadow at 9:00 AM. The children's play area, however, is in partial sun during the morning. At noon, much of the Residential Plaza, and all of the play area, lies in sunlight. At 3:00 PM, the Court is in shadow, primarily from the Fairfield and the Prudential Tower. During the winter (December 22), sunlight falls almost exclusively on the strategically located play area. From noon on, the Court is in full shade.

During October, areas of sunlight are available in the Residential Court at any time; during November, some periods show full shade. The children's play area enjoys sunlight at most times. In October, it is in sunlight during morning and afternoon hours, and during afternoon hours in November.

5) Gloucester Court

The Gloucester Court is located between the Gloucester apartment building and Lord & Taylor. It includes a children's play area at the eastern end near Exeter Street. The only new construction planned that could affect this area is the one-story neighborhood commercial center. This will have a minor impact and is the same under any alternative.

The Gloucester Court lies to the north of the Gloucestor, an existing apartment building. As such, this building dominates shadow conditions on the Court. During the summer (June 22), the Court is in partial sun during the morning and noon, and almost full sun by 3:00 PM. The children's play area is shaded only in the morning and early afternoon. During the fall and spring periods, the Gloucester Court receives partial sunlight at most times. Exceptions include late afternoon in spring, and afternoon in November. The children's play area is well located to receive a period of sunlight each day during most of the year. The Court is heavily shaded during winter.

6) Boylston Plaza and Boylston Street Pedestrian Areas

Boylston Plaza is located directly north of the proposed Boylston Office building and is, therefore, affected by its shadows. Similarly, new buildings are planned along the south side of Boylston Street, and they will shade the sidewalk along the street. This condition results from extending an existing street wall. The sidewalks along the south sides of streets throughout the Back Bay, including Boylston Street, are all largely in shade. This is a result of the east-west orientation of the grid system, and the normally continous streetwall. It should be noted that, although the Prudential Center currently is a gap in the streetwall, existing structures do contribute to shadows to the segment of Boylston Street north of the Prudential Center at various times of the day and year.

Under Alternative A, Boylston Plaza receives sunlight at all times of day in the summer. By 3:00 PM, it is in full sun. During the spring, morning and noon shadows are dominated by the Boylston Office building. In the afternoon, shadows from the Hynes Convention Center encroach on the space as well. During the fall (September 23), the Plaza is in shadow in the morning due to the new building, as well as the Fairfield. At noon, shadows from the Prudential Tower dominate. By 3:00 PM, shadows from the Hynes and the Boylston Office building both shade the plaza, but much remains in sunlight. During the later fall and winter, the Boylston Plaza is in shade.

Alternative A2 is largely the same as Alternative A, relative to shadow impacts on Boylston Plaza and Boylston Street. The main difference is that the opening between the Boylston Office building and West Boylston Residences is closed under Alternative A2. This creates some additional morning shadows that shade the Boylston Plaza during the summer and spring.

The B and C Alternatives do not result in significantly different levels of impact.

2.0 DAYLIGHT

2.1 Methodology

The purpose of this analysis is to estimate the extent to which the Prudential Center Redevelopment will affect daylight at street level, given the existing and proposed massing of buildings along the major streets. The daylight study was performed utilizing the Boston Redevelopment Authority's Daylight Analysis (BRADA)* computer software. A "fish eye" view of the building is taken at ground level from the center of adjacent city streets. The existing buildings and proposed project's footprint, setbacks, corners, and other features are plotted onto a base map using lateral and elevation angles, to provide a picture of the "sky exposure" from the point chosen.

2.2 Observation Points

For the Prudential Center Redevelopment project, the daylight analysis included calculations of the existing conditions, and of the completed pattern of development for each alternative from three different vantage points. Studies were conducted along Huntington Avenue to reflect the impacts on daylight from Stage I of the redevelopment and along Boylston Street to reflect the impacts on daylight from Stage II of the redevelopment (a complete description of the stages of redevelopment is provided in Section 6.0, Construction Impacts). Figure IV-2 shows the location of each vantage point.

For comparative purposes along each street, daylight studies were conducted to determine the maximum daylight obstruction that could result from a zoning build-out (at 125' and 155') at the Prudential Center. In addition, the daylight conditions associated with the Hynes Cnvention Center were calculated.

Two of the daylight study vantage points are on Huntington Avenue. The vantage point of View 1 is from the centerline of Huntington Avenue halfway between Belvidere Street and East Ring Road. This view gives a fairly complete analysis of the daylight obstruction from the development pattern along Huntington Avenue. The vantage point of

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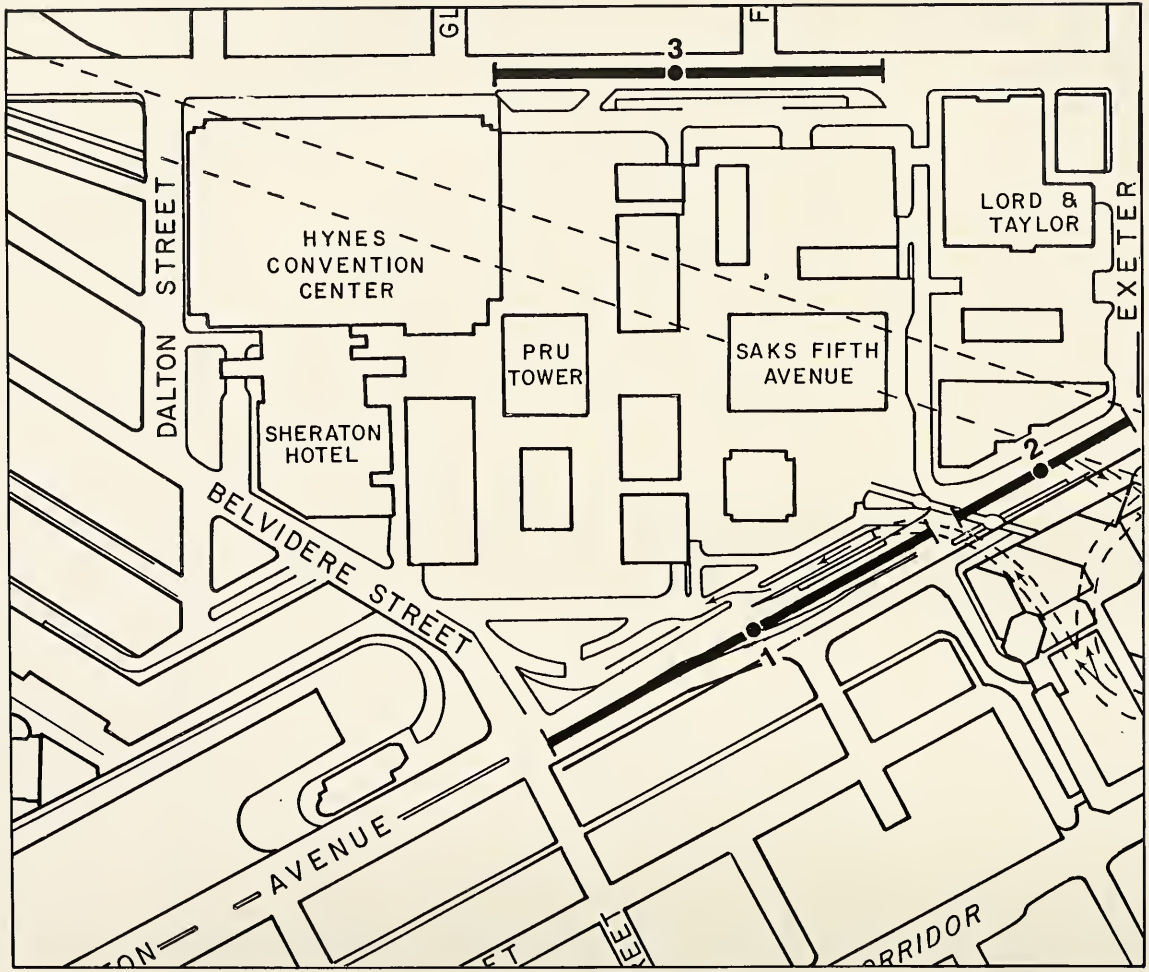
* Harvey Bryan and Susan Stuebing, "Boston Redevelopment Authority Daylight Analysis (BRADA)", MIT, Cambridge, MA.



Prudential Center Redevelopment

Fig. IV-2
Daylight Study
Vantage Points

0 100 200
Scale : feet

View 2 is from the centerline of Huntington Avenue halfway between East Ring Road and Exeter Street. This view shows the changes in daylight obstruction from the neighborhood commercial center.

The third view is on Boylston Street. The vantage point is from the centerline of Boylston Street halfway between the eastern edge of the Hynes Convention Center and East Ring Road. This view shows the changes in daylight obstruction due to the Boylston Office building and the residential buildings. Table IV-1 summarizes the results of the daylight studies for the A Alternatives. Figures IV-3 through IV-14 show elevations of existing buildings, the A Alternative buildings and graphically depicts the resulting daylight obstructions.

2.3 Analysis Results

The analysis reveals that the present configuration of the buildings at the Prudential Center, with larger buildings placed near the center of the site, well removed from roadways, results in very little obstruction of perceived daylight or "skydome" on Huntington Avenue and Boylston Street as shown in Table IV-1. Existing daylight obstruction ranges from about 16% to 23%, well below other areas in Back Bay. Figures IV-3, IV-8, and IV-10 graphically depict the obstruction from existing buildings. The horizontal axis is a view 90 degrees to the left and 90 degrees to the right of the vantage point. The vertical centerline axis is the percent of the skydome obstructed.

With the addition of buildings under the A Alternatives, skydome obstruction increases from 30% to 65%. This is due to five of the six proposed buildings being placed at the edge of the site where previously no buildings existed. The use of step-backs to upper building elevations, however, helps limit the amount of daylight obstructed. Breaking up the long-block facade of the new Boylston Street residences into three discrete building elements under the A Alternatives results in less daylight blocked than with a continuous building line along the street edge. Analyses conducted from each view with a continuous street wall along Huntington Avenue and Boylston Street allowed by zoning at the Prudential Center resulted in daylight obstruction from the mid 60's to upper 70's,* higher than the proposed project. Daylight obstruction associated with Hynes Convention Center is about 61%, higher than Alternative A and lower than A2, as experienced along Boylston Street.

---

* Based on Downtown IPOD building height standards, Appendix A, Article 27D.

TABLE IV–1
PERCENT DAYLIGHT OBSTRUCTED*

Roadway	View	DAYLIGHT OBSTRUCTED (%) Existing	Alternatives A	Alternatives A2	Zoning Build–Out** 125 ft.	Zoning Build–Out** 155 ft.
Huntington Avenue	1	23.0	56.5	57.7	65.6	71.3
Huntington Avenue	2	19.8	30.6	30.6	64.4	70.1
Boylston Street	3	16.5	51.5	65.1	75.1	79.6
OVERALL AVERAGE		19.8	46.2	51.5	68.4	73.7

* The values do not include a reduction factor based on surface reflectance effects.

** Based on Downtown IPOD building height standards, Appendix A, Article 27D.

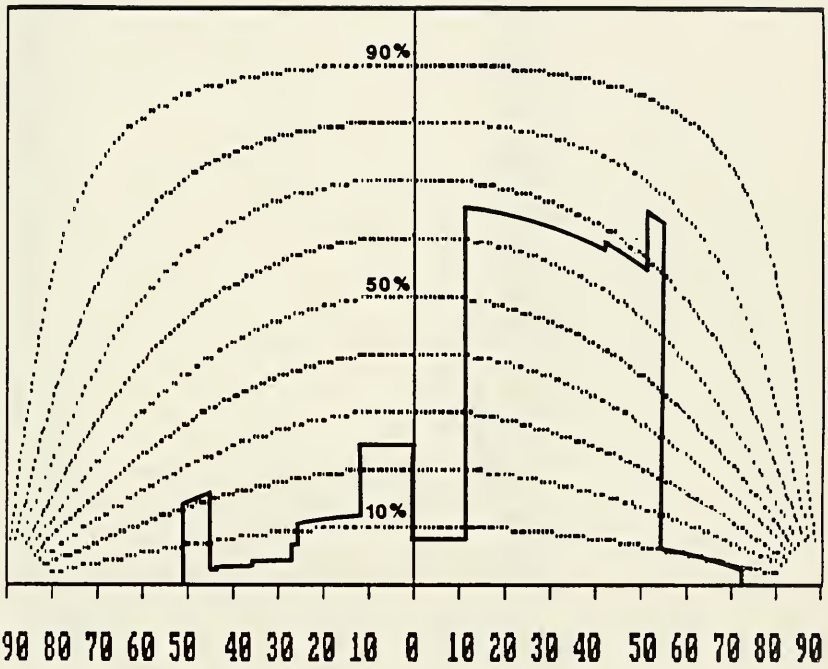
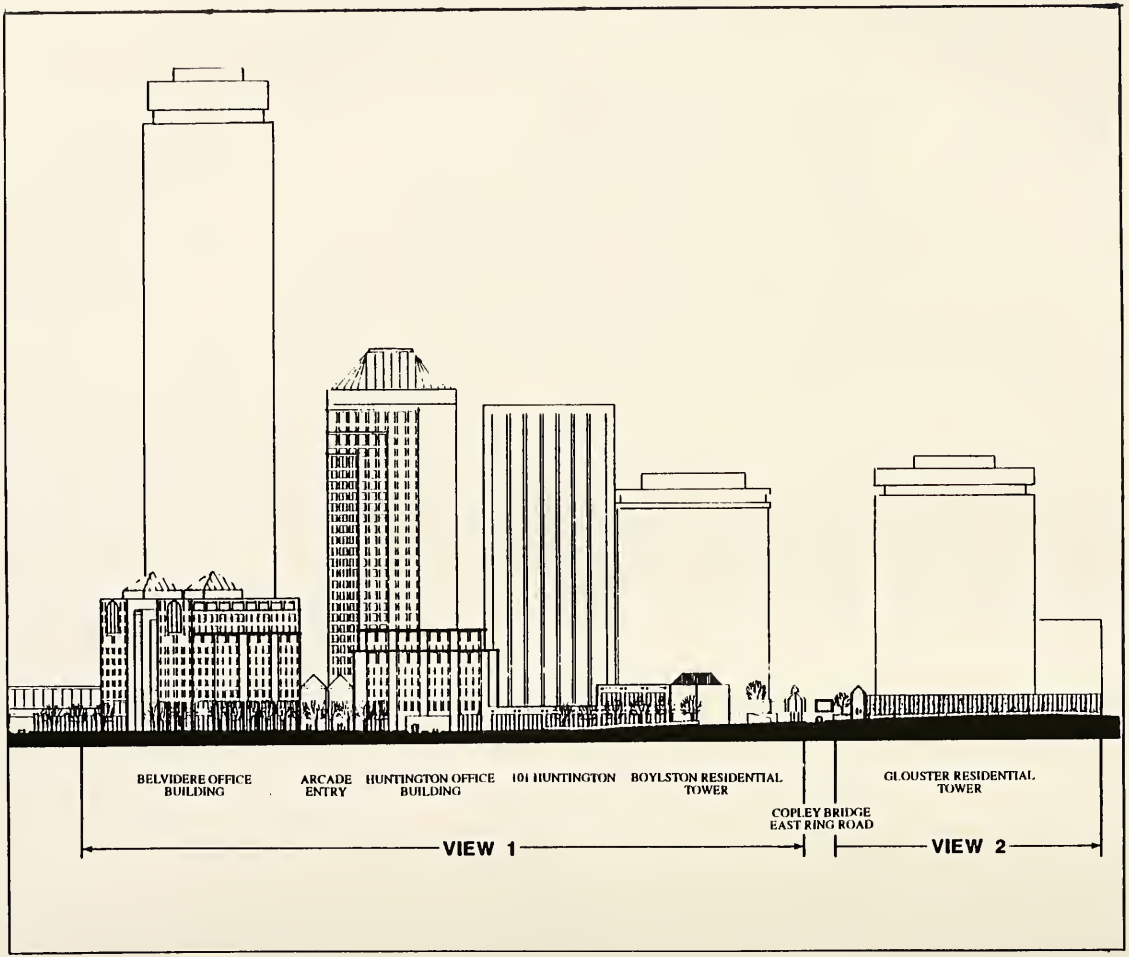


Fig. IV-3
Huntington Avenue
View 1- Existing

Fig. IV-4
Huntington Avenue
Elevation
Alternative A



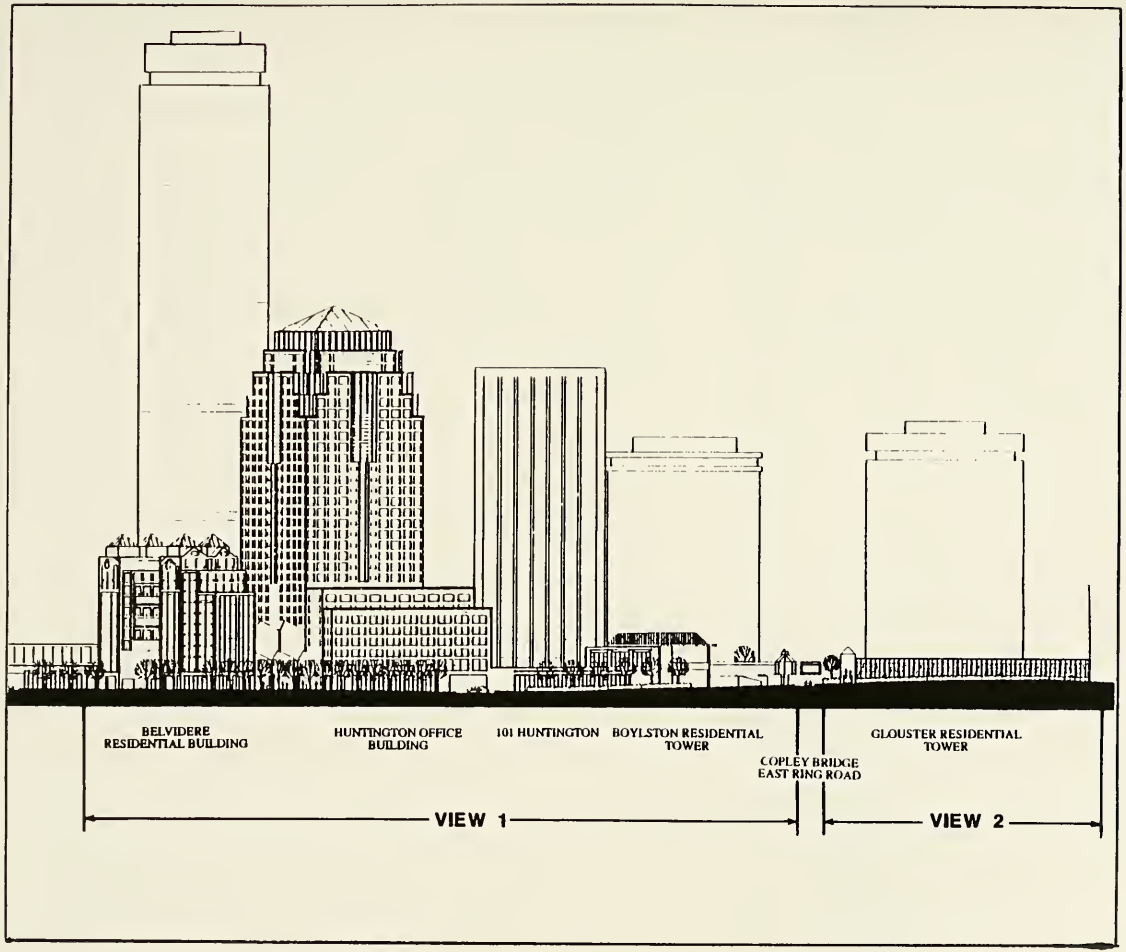


Fig. IV-5
Huntington Avenue
Elevation
Alternative A2

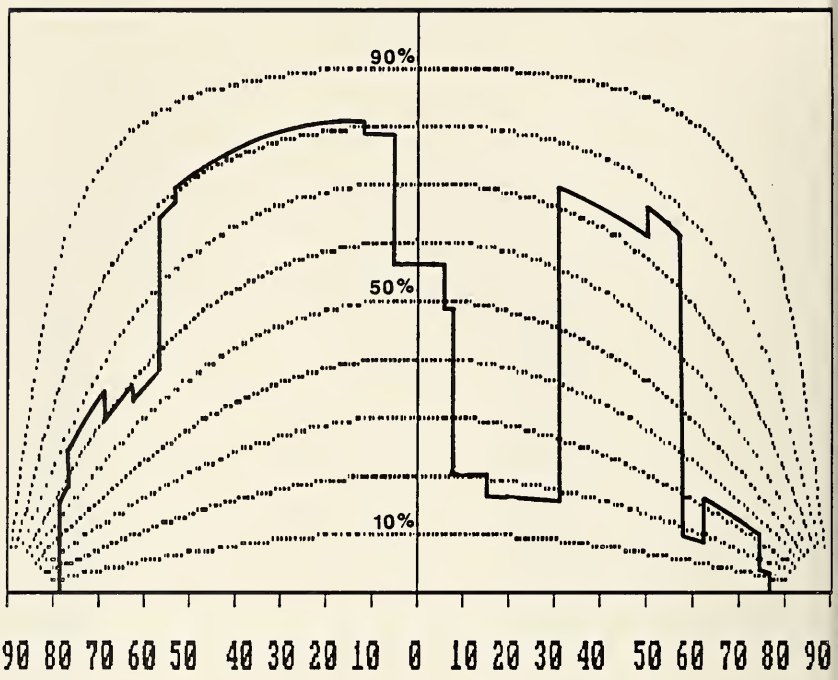


Fig. IV-6
Huntington Avenue
View 1- Alternative A

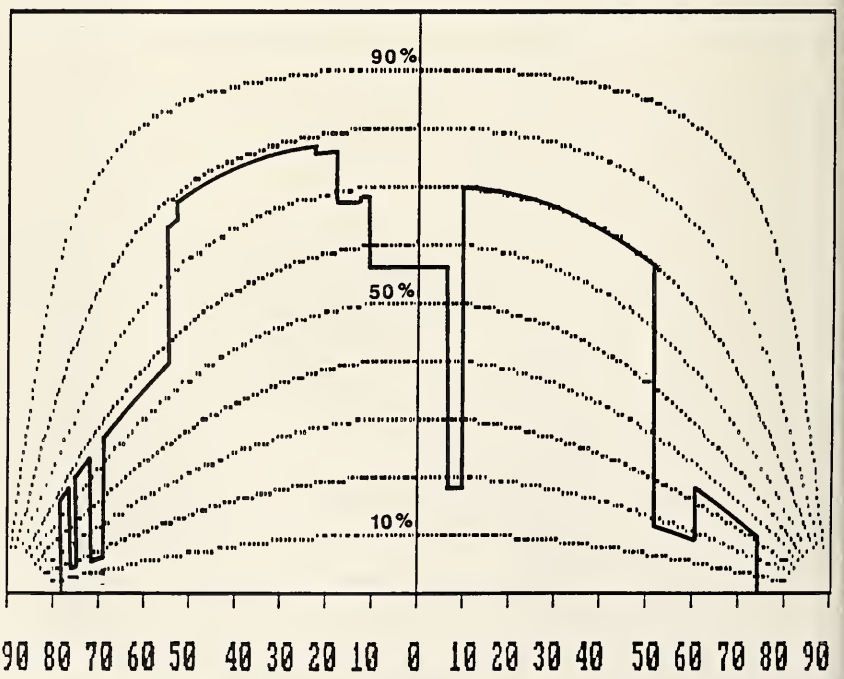


Fig. IV-7
Huntington Avenue
View 1- Alternative A2

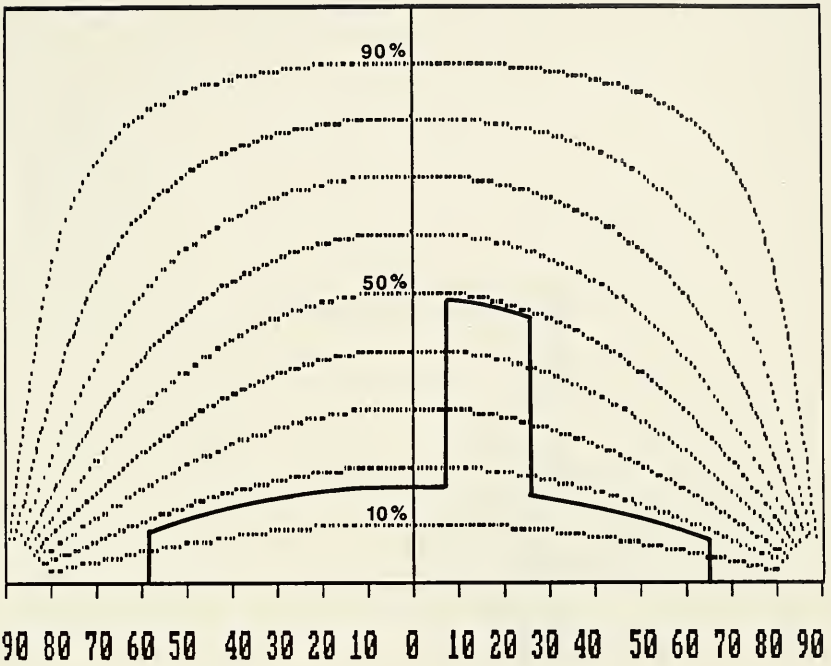


Fig. IV-8
Huntington Avenue
View 2- Existing

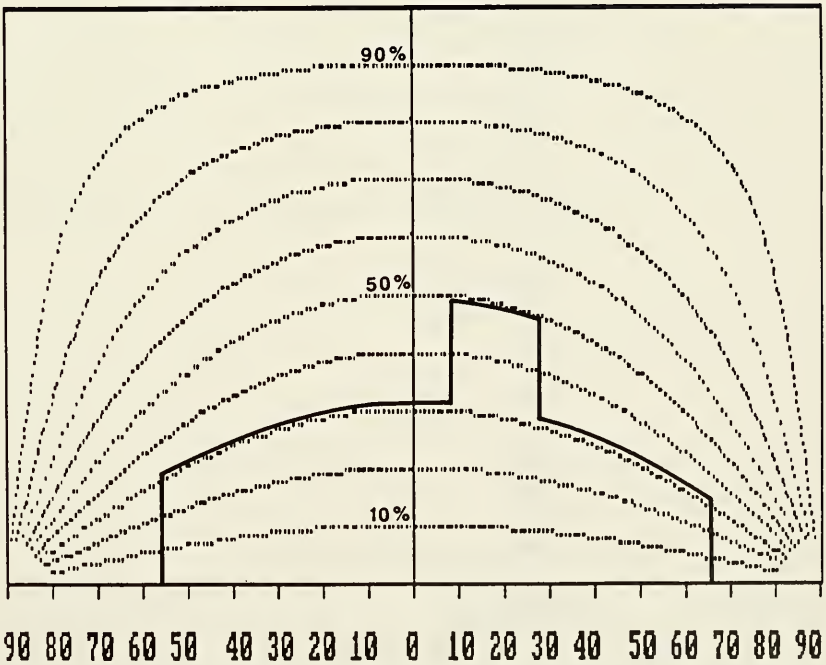


Fig. IV-9
Huntington Avenue
View 2
All Alternatives

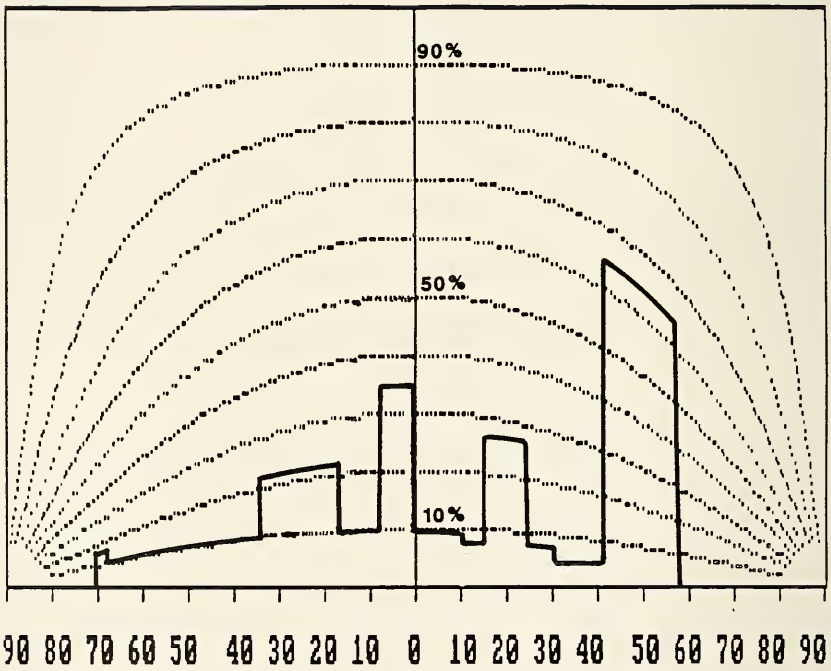


Fig. IV-10
Boylston street
View 3- Existing

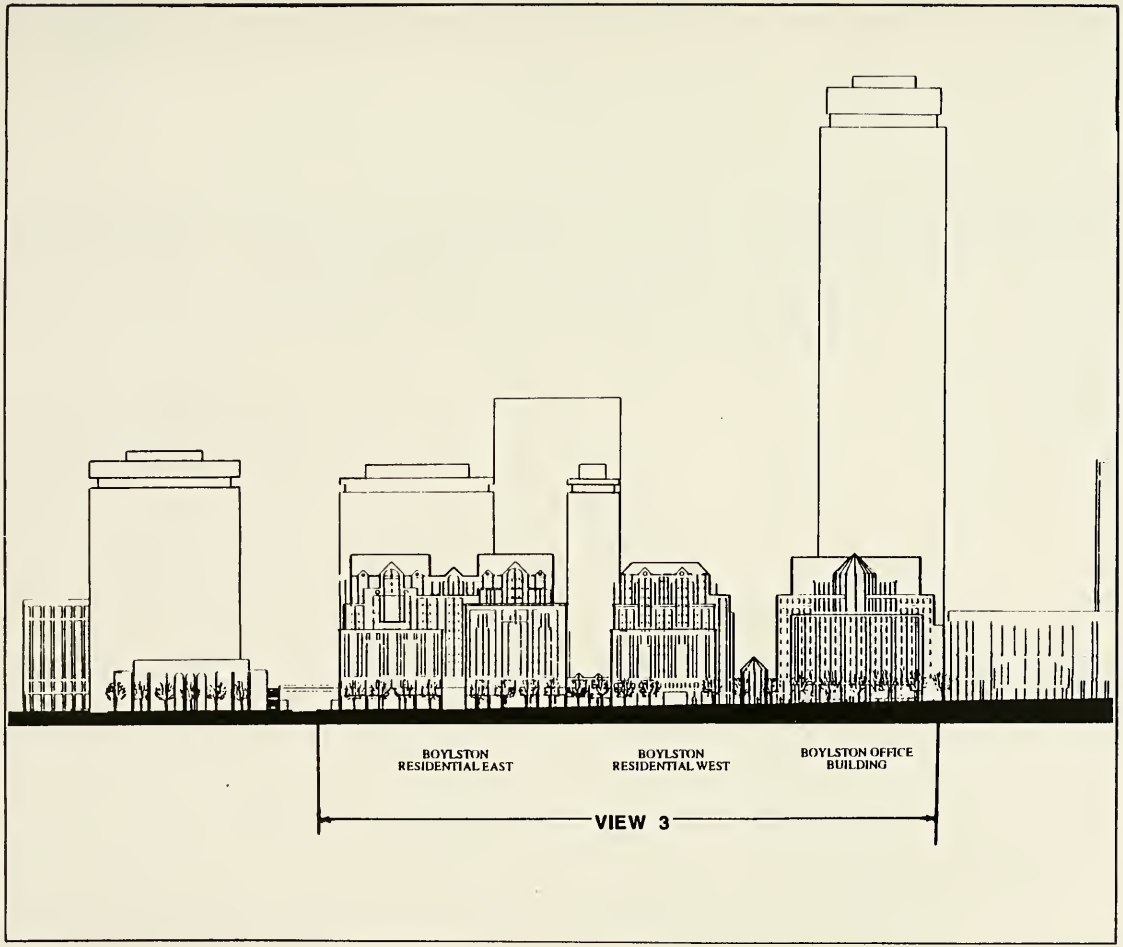
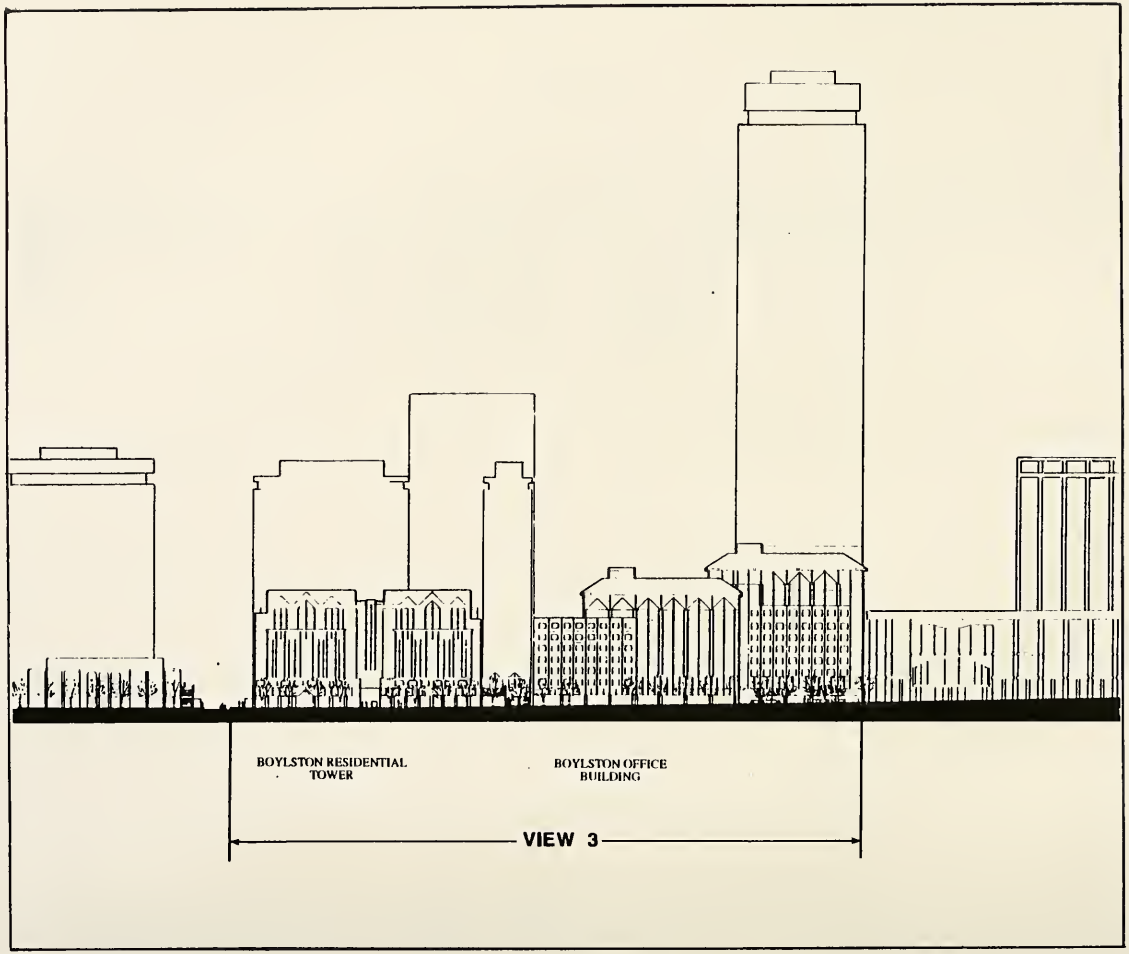
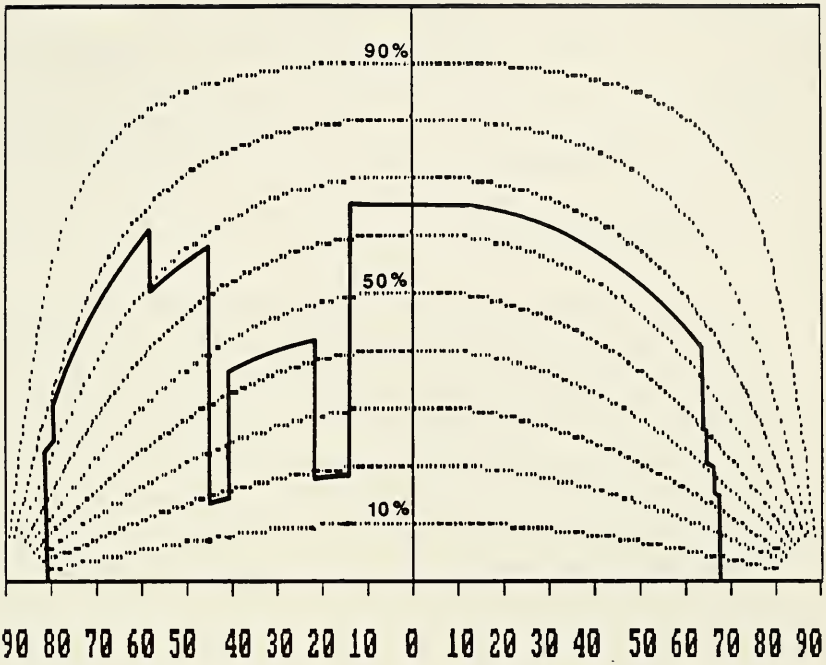


Fig. IV-11
Boylston Street
Elevation
Alternative A

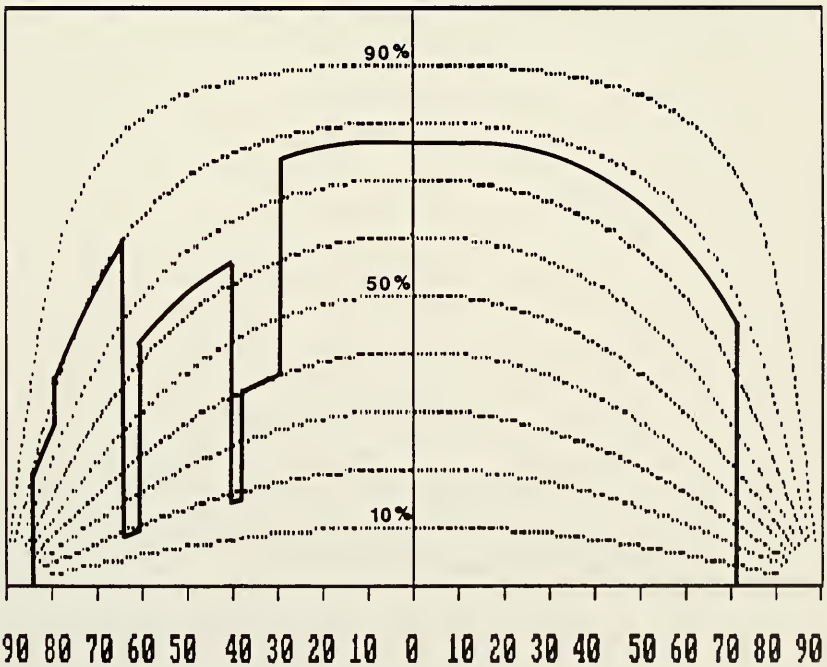


Prudential Center Redevelopment

Fig. IV-12
Boylston Street Elevation
Alternative A2



ig. IV-13
oylston Street
iew 3- Alternative A



ig. IV-14
oylston Street
iew 3- Alternative A2

The remaining alternatives result in similar obstructions of daylight along Huntington Avenue and Boylston Street since the locations of the new buildings are approximately the same in each alternative. As building heights decline, sky exposure increases slightly.

Huntington Avenue Views

Under existing conditions, the amount of daylight obstructed on Huntington Avenue from buildings at the Prudential Center is small (up to 23 percent). The commercial blocks, the Prudential Tower, 101 Huntington Avenue, and the Gloucester apartment building obstruct daylight along this Avenue. Under the site's present configuration, these major buildings are set back from the street edge. With a full zoning build–out, daylight obstruction along Huntington Avenue could reach about 71 percent.

A representative perspective of the daylight impacts on Huntington Avenue of the A Alternatives is View 1, shown in Figure IV–6 and IV–7, encompassing the segment of Huntington Avenue from Belvidere Street to East Ring Road. The percent of daylight obstruction increases to the mid 50's for View 1 under A Alternatives. A major part of the increase is from the lowest tier of the two office buildings closest to the street edge. The step–backs to the higher building elevations of the Belvidere Office building and the Huntington Office building significantly limits the daylight obstructed from these higher elevations. The second view shows the daylight obstructed from the neighborhood commercial center. As shown in Figure IV–9, this building, which is at the street edge but is only 40 feet high, results in 30.6 percent of available daylight being obstructed for all the alternatives.

Boylston View

Under the existing conditions, little daylight is blocked on Boylston Street (16.5 percent), as shown in Figure IV–10. The Fairfield apartment building, Prudential Tower, commercial blocks, and the 20–foot plaza level obstruct daylight. The configuration of the A Alternatives, shown in Figures IV–13 and IV–14, increases daylight obstruction to about 50 percent. These compare to 61% obstruction resulting from the Hynes Convention Center. With a 155–foot build–out, daylight obstruction could reach 79.6 percent. The increased obstruction is due primarily to lower tiers close to the Boylston Street edge. The Boylston Street office building contributes less to daylight obstruction since it is set back from the street edge.

2.4 Impacts of Alternatives

Daylight studies conducted for Alternatives B, B2, C, and C2 are shown in Appendix B. For the Belvidere Office building, the first two tiers of the building are at the same height or about 20 to 30 feet lower than Alternative A, with the exception of Alternative B. The daylight obstruction from the Belvidere Office building for each alternative is very similar.

For the Huntington Office building, the first two tiers of the building are at the same height in all alternatives so the daylight obstruction due to this building is approximately the same for each alternative. The reduced density alternatives show slightly less obstruction from this building.

The neighborhood commercial center is identical for each alternative, therefore, the daylight obstruction from each alternative is the same.

For the Boylston Street buildings, the differences in height of the B and C Alternatives do not significantly change the percent daylight obstruction. Values calculated for these alternatives vary less than ten percent from the Alternative A values.

2.5 Summary

In general, the overall average daylight obstructed at the project site, from the three major vantage points considered, may increase from about 17 percent under the existing configuration to about 52 percent with construction of the Prudential Center Redevelopment project. The 52 percent daylight obstructed with the project, however, is about 20 percent less than the daylight obstruction possible from a 155–foot build–out. It compares closely with a 1:1 street width to building height ratio (50%) that is often considered a comfortable, non–canyonlike urban environment. Thus, the redeveloped Prudential Center will maintain an open character in comparison to other areas within the City of Boston.

3.0 AIR QUALITY

3.1 Introduction

The objective of the air quality analysis is to verify that operation of the Prudential Center upon completion of the redevelopment project, will not cause violations of the Massachusetts and National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO). These standards, established under the Federal Clean Air Act, are designed to protect public health and welfare. To demonstrate compliance, areas of human activity (sensitive receptors) exposed to maximum air pollutant levels from motor vehicle emissions in the project area are identified. Using air quality modeling techniques, CO levels are then estimated at these sensitive receptors under the build and no-build cases. Projected pollutant levels are then compared to the NAAQS.

The air quality analysis is based on a modeling protocol developed in coordination with and approved by the Boston Redevelopment Authority (BRA) and the Massachusetts Department of Environmental Quality Engineering (DEQE) as required by the BRA scoping determination.

3.2 Pollutant Sources and Standards

Of the six pollutants regulated by the NAAQS, four are emitted by motor vehicles or formed from their emissions: carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3), and lead (Pb). Carbon monoxide is used in this analysis as an indicator of roadway air pollution levels, as it is the most abundant and persistent pollutant emitted by motor vehicles. Its nonreactive properties also allow pollutant transport and dispersion to be modeled.

National Ambient Air Quality Standards (NAAQS) for carbon monoxide have been set by the U.S. Environmental Protection Agency (EPA). Standards for the Commonwealth of Massachusetts are identical to the Federal standards. Primary standards which exist for CO are intended to protect the public health. The primary CO standards set a maximum concentration of 35 parts per million (ppm) for a one-hour period, and 9 ppm for an eight-hour period, each not to be exceeded more than once per year.

3.3 Background Air Quality

Background air quality concentrations reflect the generalized level of pollutants in the project area to which the emissions of new traffic are added. Background levels in the project area recommended for use by the Massachusetts Department of Environmental Quality Engineering (DEQE) are 5.0 ppm and 3.0 ppm for the peak one-hour and eight-hour periods, respectively.*

3.4 Study Approach

The Prudential Redevelopment air quality analysis was based on DEQE* and BRA* recommended procedures. The analysis calculated maximum one-hour and eight-hour CO concentrations at sensitive receptors located adjacent to six key intersections in the project area. The six intersections analyzed were:

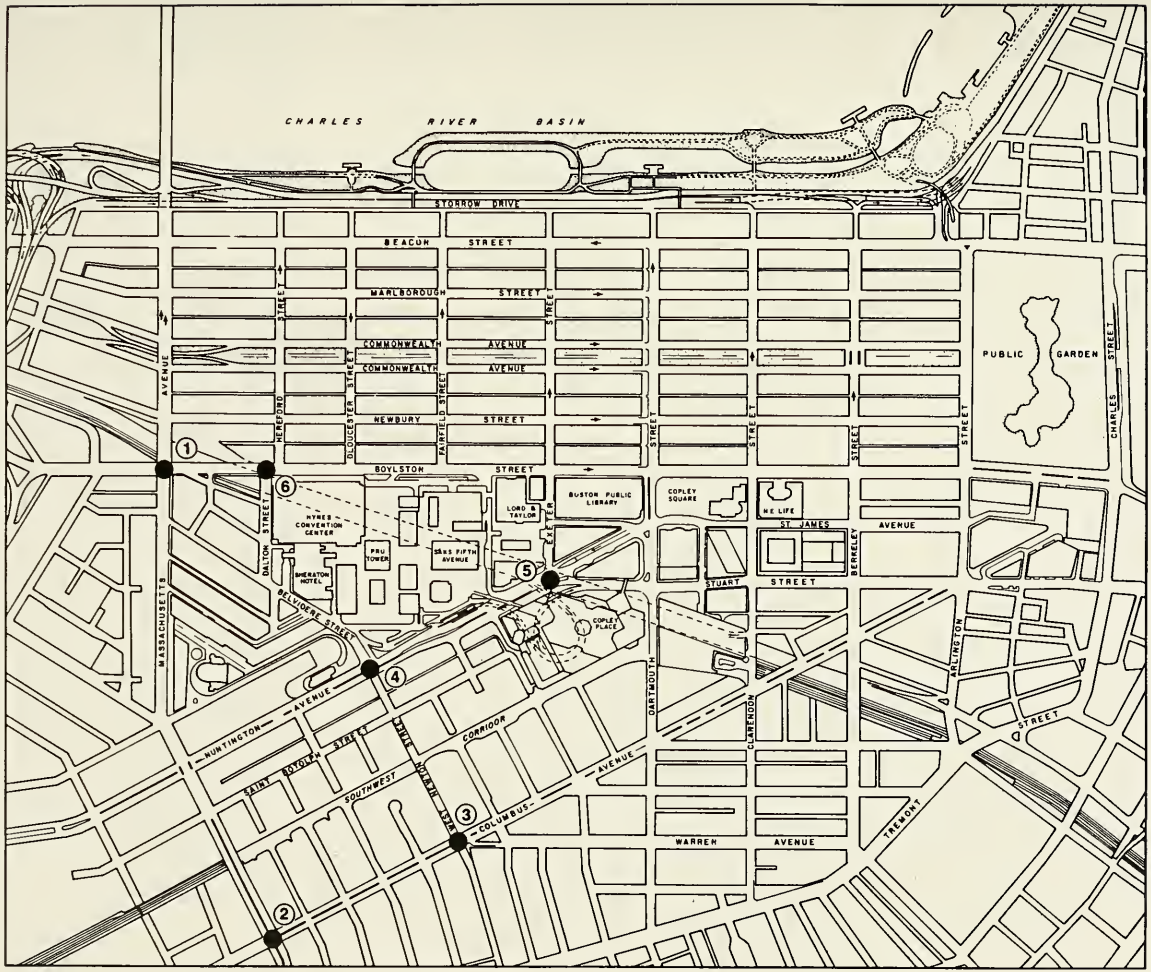
- Massachusetts Avenue/Boylston Street
- Massachusetts Avenue/Columbus Avenue
- Columbus Avenue/West Newton Street
- Huntington Avenue/West Newton Street/Belvidere Street
- Huntington Avenue/Exeter Street/Stuart Street
- Boylston Street/Dalton Street/Hereford Street

The locations of these intersections are shown in Figure IV-15.

The intersections were selected in cooperation with the DEQE and BRA. These intersections represent locations where the project is expected to increase traffic volumes and potentially reduce level-of-service. For each intersection studied, the following cases were considered:

Case No.	Year	Project Scenario
1	1988	Existing
2	1994	No-Build
3	1994	Build (Alternative A)
4	1994	Build with Mitigation
5	1999	No-Build
6	1999	Build (Alternative A)
7	1999	Build with Mitigation

* Personal Communication, Mr. Jerome Grafe, DEQE, and Mr. Richard Mertens, BRA, Boston, MA, December 6, 1988, and January 20 and 23, 1989.



Prudential Center Redevelopment

Fig. IV-15 Intersections Analyzed For Air Quality Study

1. Massachusetts Ave/ Boylston Street
2. Massachusetts Ave/ Columbus Ave
3. Columbus Ave/ West Newton Street
4. Huntington Ave/ West Newton Street/ Belvidere Street
5. Exeter Street/ Stuart Street/ Huntington Avenue
6. Boylston Street/ Dalton Street/ Hereford Street

0 200 400
Scale : feet

The cases analyzed in 1994 represent the completion of Stage I; the 1999 cases represent the completion of Stage II (Stages I and II are described in Section 6.0, Construction Impacts).

For each case the recommended EPA MOBILE3* and EPA CALQ3** computer programs were used to calculate motor vehicle emissions and CO concentrations at intersections. CALQ3 is a version of FHWA's CALINE3+ model with enhancements allowing motor vehicle queuing at intersections to be considered.

Emissions data calculated by the MOBILE3 model were based on motor vehicle operating conditions typical of peak one-hour and eight-hour periods. In addition, the analysis incorporated the effects of the Commonwealth's statewide inspection and maintenance (I&M) program designed to control emissions of CO from motor vehicles. These emissions data were used as input to the CALQ3 model to predict CO concentrations. MOBILE3 and CALQ3 modeling and assumptions are detailed in Appendix C.

The study used peak one-hour traffic volumes at each intersection for the design hour based on the traffic data contained in Prudential Center Redevelopment Transportation Access Plan (DPIR/EIR Volume III). Peak eight-hour volumes for approaches at intersections were calculated by multiplying an eight-hour to one-hour factor times the peak one-hour traffic data. Peak eight-hour to one-hour factors were based on actual traffic counts and ranged from 0.81 to 0.85.

Receptor locations were chosen to be consistent with the recommendations in EPA Guidelines++ specifically: 1) where maximum carbon monoxide concentrations are likely to occur (i.e., adjacent to intersection vehicle queues), and 2) where the general public is likely to have access. Receptor locations and intersection geometries are shown in Figures IV-16 through IV-21.

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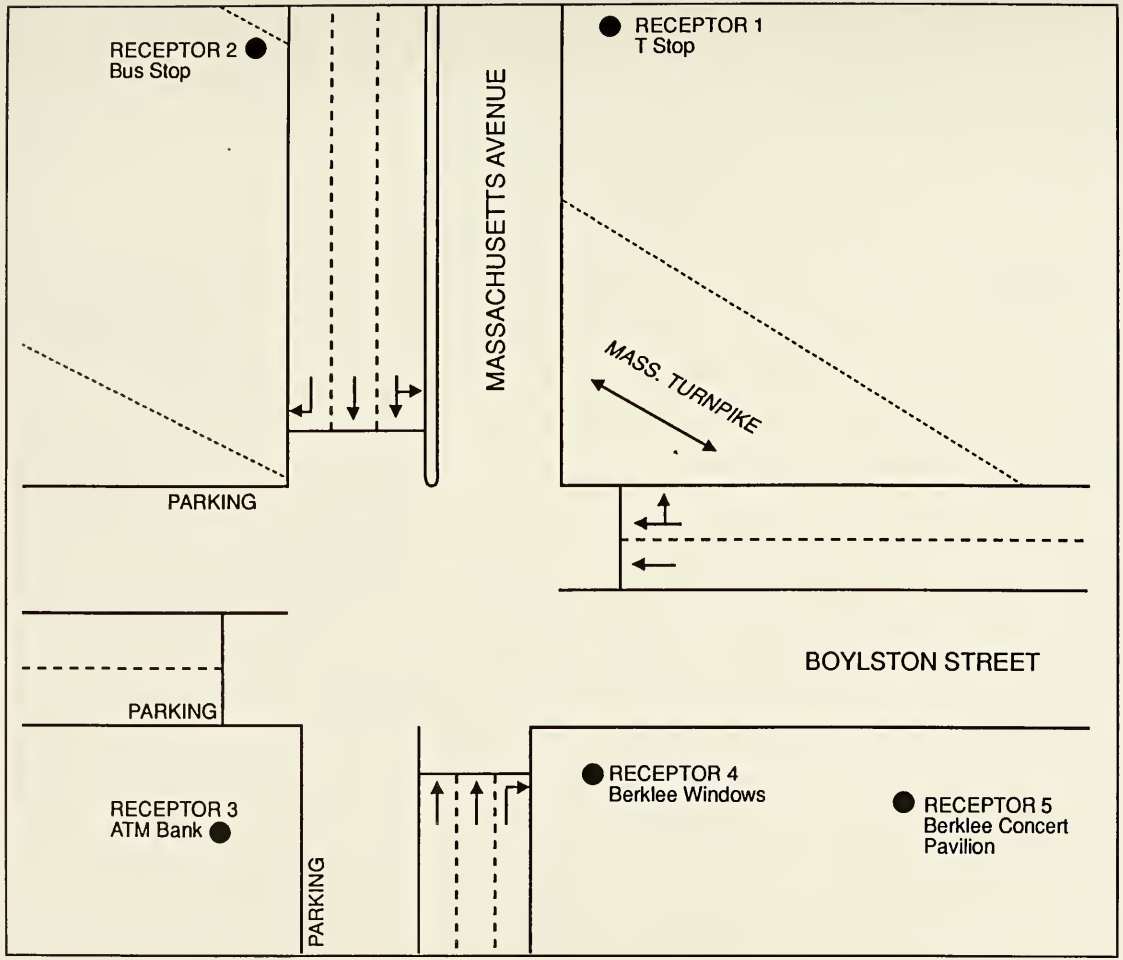
* EPA, User's Guide to MOBILE3: Mobile Source Emissions Model, EPA-460/3-84-002, Ann Arbor, MI, June 1984.

** EPA Region I, "CALQ3 Modeling Procedures," January 3, 1986.

\+ FHWA, CALINE3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets, FHWA/CA/TL-79/23, November, 1979.

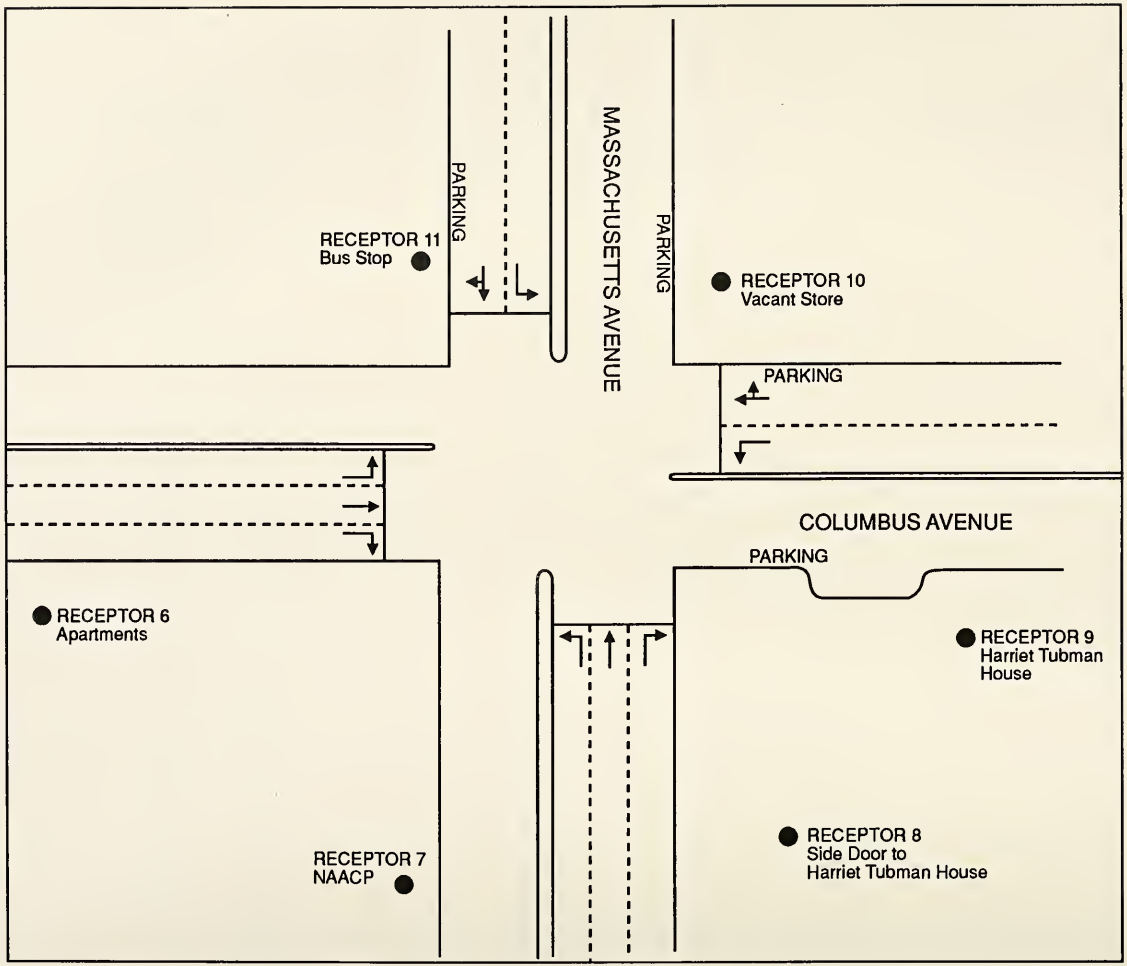
++ EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9, (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park.



Prudential Center Redevelopment

Fig. IV-16
Massachusetts / Boylston Intersection

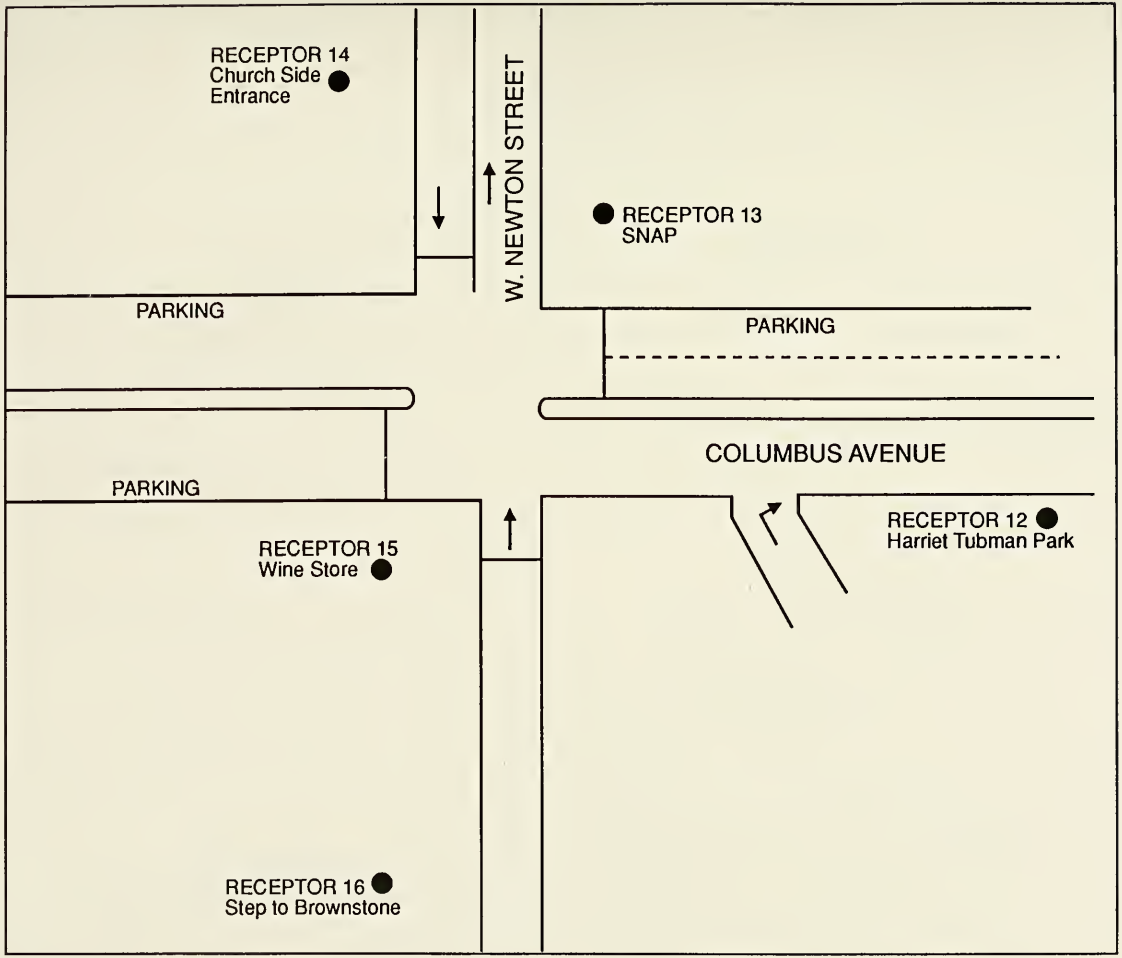
0 20 40
Scale : feet



Prudential Center Redevelopment

Fig. IV-17
Massachusetts / Columbus Intersection

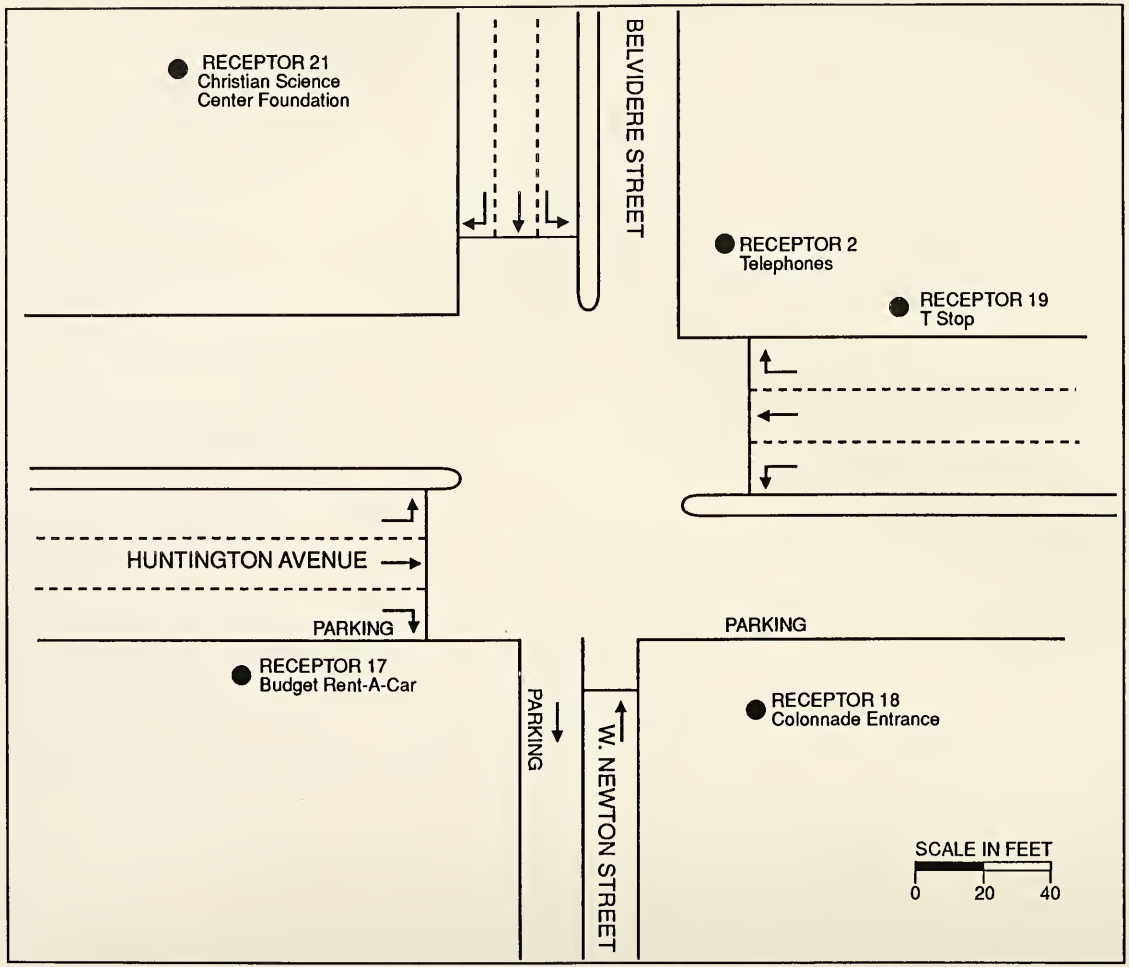
0 20 40
Scale: feet



Prudential Center Redevelopment

Fig. IV-18
Columbus / West Newton Intersection

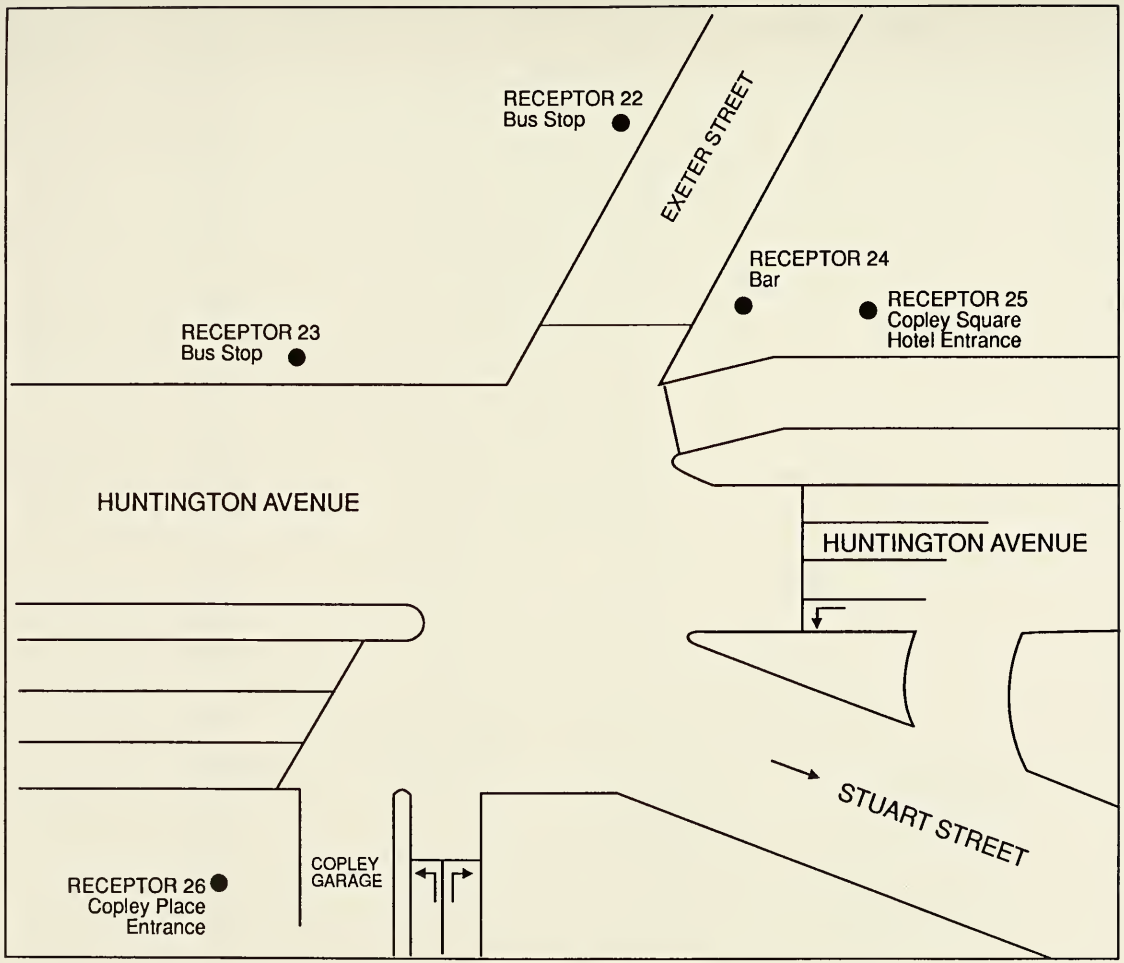
0 20 40
Scale : feet



Prudential Center Redevelopment

Fig. IV-19
Huntington / Belvidere / West Newton Intersection

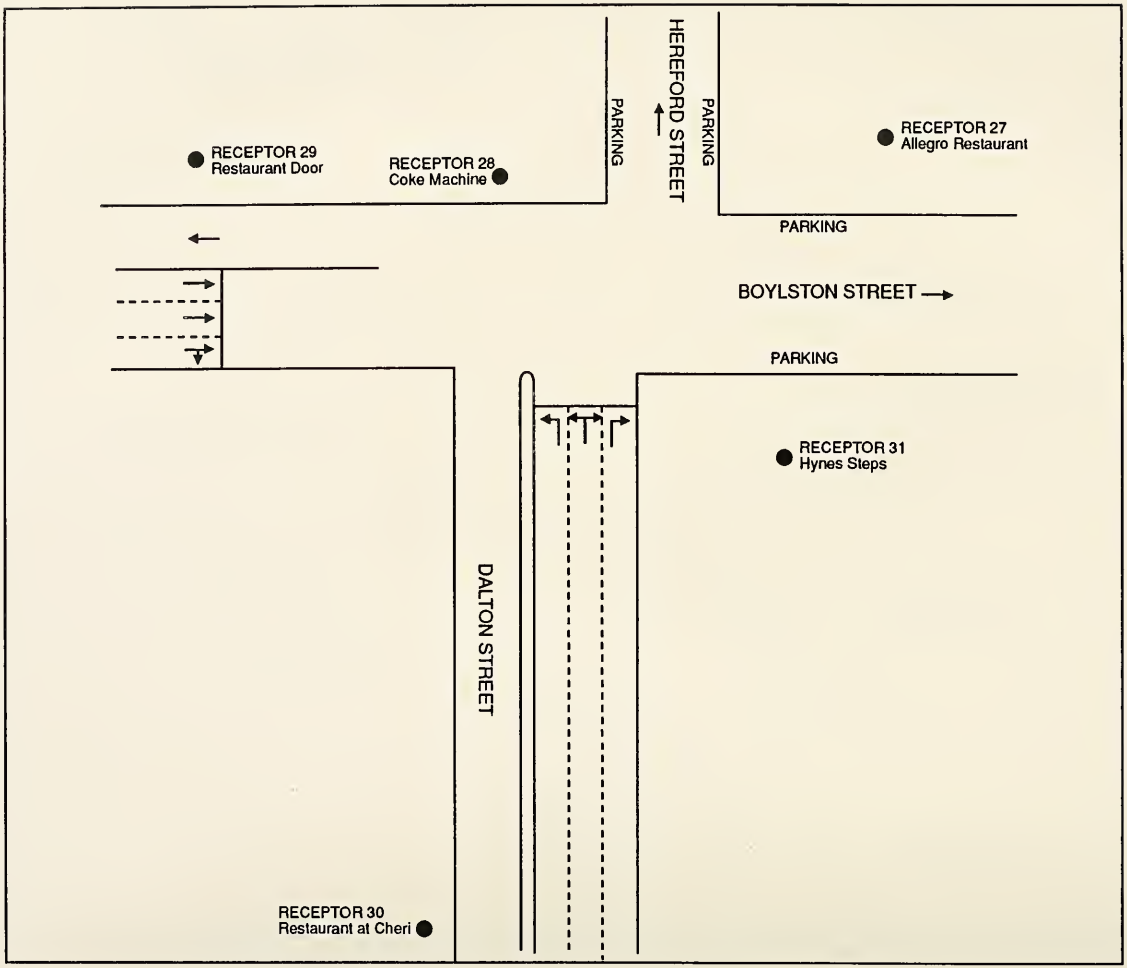
0 20 40
Scale: feet



Prudential Center Redevelopment

Fig. IV-20
Huntington / Exeter / Stuart Intersection

0 20 40
Scale: feet



Prudential Center Redevelopment

Fig. IV-21
Boylston / Dalton / Hereford Intersection

0 20 40
Scale : feet

Additional modeling was performed to address impacts of the project's parking garages, Massachusetts Turnpike Extension, and Massachusetts Turnpike tunnel under the Prudential Center. Impacts from the Massachusetts Turnpike Extension were calculated using the CALQ3 model. The garage and tunnel ventilation analyses used the EPA MOBILE3 and EPA Indirect Source Guidelines* to determine emission rates. Halitsky's gas diffusion equation was used to model ventilation (exhaust) openings in order to determine CO contributions at the receptors examined in the intersection analysis. Appendix C includes a more detailed explanation of the modeling techniques.

3.5 Results

Maximum one-hour and eight-hour CO concentrations from all sources modeled are presented in Table IV-2. These values represent concentrations that could exist during the simultaneous occurrence of worst case meteorology and peak traffic. Typical pollution levels are expected to be lower than these worst case values. Worst case CO impacts at each intersection are as follows:

Massachusetts Avenue/Boylston Street

Predicted CO impacts at this intersection indicated no violations of the one-hour NAAQS under any case. The analysis, however, did demonstrate violations of the eight-hour standard at all five receptors in the existing case. There are no exceedences of the eight-hour NAAQS in any case in 1994 or 1999.

The maximum predicted one-hour concentration is 22.2 ppm under the existing case located at receptor 2; a bus stop located on the Massachusetts Avenue bridge over the Turnpike. The maximum eight-hour concentration is 11.0 ppm, also located at receptor 2.

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* EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9, (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park.

TABLE IV-2
CUMULATIVE CARBON MONOXIDE CONCENTRATIONS (ppm)

Intersection	Receptor Number	1988 Existing 1-Hr	1988 Existing 8-Hr	1994 No-Build 1-Hr	1994 No-Build 8-Hr	1994 Build 1-Hr	1994 Build 8-Hr	1994 Build With Mitigation 1-Hr	1994 Build With Mitigation 8-Hr	1999 No-Build 1-Hr	1999 No-Build 8-Hr	1999 Build 1-Hr	1999 Build 8-Hr	1999 Build With Mitigation 1-Hr	1999 Build With Mitigation 8-Hr
Boylston/ Massachusetts	1	18.4	**9.1**	14.7	7.3	15.1	7.4	15.1	7.4	14.3	7.1	15.1	7.3	15.1	7.3
	2	22.2	**11.0**	17.9	8.6	18.2	8.7	18.2	8.7	17.8	8.2	18.3	8.4	18.4	8.4
	3	18.2	**9.8**	14.7	7.5	14.9	7.6	14.9	7.6	14.0	7.2	14.5	7.3	14.5	7.3
	4	18.4	**9.8**	15.1	7.4	15.5	7.5	15.4	7.5	15.3	7.0	15.7	7.3	15.7	7.3
	5	21.1	**10.1**	18.0	8.2	18.3	8.7	18.3	8.7	18.1	8.2	18.6	8.5	18.6	8.5
Massachusetts/ Columbus	6	14.9	7.2	11.2	5.8	11.4	5.8	11.6	6.3	10.3	5.3	10.8	5.6	11.1	5.6
	7	15.6	7.6	12.4	6.3	12.6	6.5	12.4	6.5	11.1	5.8	11.7	6.0	11.9	6.1
	8	13.9	7.4	10.9	5.8	11.0	5.8	11.2	6.0	10.0	5.4	10.3	5.4	10.9	5.6
	9	15.5	8.8	11.9	6.5	12.1	6.8	11.8	6.5	11.0	6.0	11.3	6.2	11.2	6.1
	10	16.7	8.2	12.9	6.4	13.1	6.5	13.3	6.8	11.7	5.9	12.2	6.2	12.6	6.5
	11	22.6	**11.2**	16.5	8.5	16.8	8.6	16.3	8.2	14.7	7.7	15.5	7.8	14.8	7.4
Columbus/ W. Newton	12	12.3	6.3	10.5	5.3	10.7	5.3	10.6	5.3	9.9	5.0	10.2	5.1	10.2	5.1
	13	12.7	7.3	10.5	5.8	10.6	5.9	10.6	5.9	9.7	5.4	10.0	5.5	10.0	5.5
	14	14.5	7.8	11.4	6.1	11.7	6.3	11.6	6.2	10.6	5.8	11.1	6.0	11.0	5.9
	15	14.1	6.8	11.2	5.7	11.6	6.0	11.4	5.6	10.5	5.6	11.3	5.6	11.1	5.5
	16	11.7	5.9	9.3	4.8	9.7	5.0	9.6	4.8	8.9	4.8	9.4	5.0	9.3	4.8
Huntington/ Belvidere/ W. Newton	17	21.5	**13.9**	15.7	**9.8**	17.3	**9.9**	16.9	**9.6**	14.9	8.8	16.4	8.9	16.2	8.7
	18	16.2	8.8	12.9	6.8	14.3	7.6	14.0	7.2	12.1	6.4	13.7	7.0	13.2	6.7
	19	24.8	**12.9**	18.9	**9.9**	22.0	**11.5**	18.7	**9.5**	17.3	8.9	20.5	**10.3**	17.6	8.8
	20	24.7	**10.4**	15.1	8.1	16.9	**9.0**	15.6	8.2	13.8	7.4	16.1	8.3	14.8	7.5
	21	16.1	8.8	12.7	6.8	14.3	7.5	14.1	7.5	11.8	6.3	13.8	7.0	13.5	7.0
Huntington/ Stuart/ Exeter	22	22.9	**12.7**	17.7	**9.3**	17.8	**9.5**	17.3	**9.2**	16.7	8.9	16.9	8.9	16.5	8.6
	23	18.9	**10.0**	15.5	7.8	15.7	8.0	15.3	7.8	15.3	7.7	15.4	7.7	15.1	7.7
	24	23.2	**12.6**	18.2	**9.5**	18.3	**9.6**	17.8	**9.0**	17.4	**9.0**	17.6	**9.1**	17.5	8.8
	25	21.8	**11.8**	17.2	**9.2**	17.2	**9.2**	16.9	8.6	16.7	8.7	16.8	8.7	16.6	8.4
	26	26.1	**14.1**	20.5	**10.6**	20.5	**10.8**	20.5	**10.6**	19.7	**10.2**	19.8	**10.2**	19.8	**10.2**
Boylston/ Dalton/ Hereford	27	12.2	6.2	10.9	5.7	11.5	5.9	11.5	5.9	10.4	5.4	11.3	5.7	11.3	5.7
	28	15.3	7.6	13.3	6.8	14.2	7.2	14.0	7.0	12.6	6.3	13.6	6.8	13.6	6.8
	29	13.9	7.5	11.2	5.9	11.5	6.0	11.5	6.0	10.5	5.6	11.3	5.8	11.3	5.8
	30	13.5	6.7	13.0	6.3	14.2	7.1	14.2	6.5	12.1	5.9	13.7	6.5	13.7	6.5
	31	15.6	8.5	12.5	6.7	13.0	7.0	13.0	6.9	11.5	6.3	12.6	6.5	12.6	6.5

In 1994, the maximum predicted one-hour concentration is 18.3 ppm in the Build and Build with traffic mitigation case. This is located at receptor 5, the Berklee Concert Pavilion. This value represents an increase of 0.3 ppm over the No-Build case. The maximum eight-hour impact is 8.7 ppm at receptors 2 and 5 in the Build and Build with Traffic Mitigation cases. These values are a 0.1 ppm increase at receptor 2 and 0.5 ppm increase at receptor 5 over the No-Build case.

In 1999, the maximum predicted one-hour concentration is 18.6 ppm in the Build and Build with Traffic Mitigation cases, located at receptor 5. This is a 0.5 ppm increase over the No-Build case. The maximum predicted eight-hour concentration is 8.5 ppm in both the Build and Build with Traffic Mitigation cases, a 0.3 ppm increase over the No-Build case.

Massachusetts Avenue/Columbus Avenue

Predicted CO impacts at this intersection indicated no violations of the one-hour NAAQS under any year. In the existing case, there is one exceedence of the eight-hour NAAQS. There are no violations of the eight-hour NAAQS predicted for any case in the future study years.

In the existing case, the maximum predicted one-hour concentration of 22.6 ppm occurs at receptor 11, located at the Massachusetts Avenue southbound bus stop. The maximum predicted eight-hour concentration is 11.2 ppm, also at receptor 11. This value is a 2.2 ppm exceedence of the eight-hour NAAQS of 9.0 ppm.

In 1994, the maximum predicted one-hour concentration is 16.8 ppm in the Build case at receptor 11. This value represents an increase of 0.3 ppm over the No-Build case. With project-related traffic mitigation, this value decreases to 16.3 ppm, a 0.5 ppm improvement over the Build case, and 0.2 ppm improvement over the No-Build case. The maximum predicted eight-hour concentration in 1994 is 8.6 ppm. This occurs at receptor 11 in the Build case. The Build with Traffic Mitigation predicted concentration is 8.2 ppm, a 0.4 ppm improvement over the Build case, and 0.3 ppm improvement over the No-Build case.

In 1999, the maximum predicted impact is 15.5 ppm, at receptor 11, in the Build case. This value represents a 0.8 ppm increase over the No–Build case. The Build with Traffic Mitigation case has a predicted concentration at this receptor of 14.8 ppm, a 0.7 ppm improvement from the Build case. The maximum predicted eight–hour concentration is 7.8 ppm, also at receptor 11, a 0.1 ppm increase over the No–Build case. The Build with Traffic Mitigation case has a predicted concentration of 7.4 ppm, a 0.4 ppm improvement from the Build case and 0.3 ppm improvement from the No–Build case.

Columbus Avenue/West Newton Street

Predicted impacts at this intersection indicate no violation of the one–hour and eight–hour NAAQS under any case in any study year. The maximum predicted one– and eight–hour CO concentrations are 14.5 ppm and 7.8 ppm, respectively.

In 1994, the maximum one–hour concentration is 11.7 pm (receptor 14) in the Build case. This represents a 0.3 ppm increase over the No–Build case. In the Build with Traffic Mitigation case, this concentration decreases to 11.6 ppm. The maximum eight–hour concentration is 6.3 ppm at receptor 14 in the Build case; representing a 0.2 ppm increase over the No–Build case. Proposed mitigation lowered this concentration to 6.2 ppm.

In 1999, the maximum one–hour concentration is 11.3 ppm, occuring under the Build case at receptor 15, a wire shop. This value represents a 0.8 ppm increase over the No–Build case. With traffic mitigation this concentration decreases to 11.1 ppm. The maximum predicted eight–hour concentration is 6.0 ppm at receptor 14 in the Build case, representing a 0.2 ppm increase over the No–Build case. The Build with Traffic Mitigation predicted concentration at this receptor is 5.9 ppm, a 0.1 ppm decrease from the Build case.

Huntington Avenue/Belvidere Street/West Newton Street

Predicted CO levels at this intersection indicate no violation of the one-hour NAAQS in any case. In the existing case, there are three receptors whose maximum predicted concentration exceeds NAAQS. In 1994, there are two receptor locations that demonstrate violations in the Build with Traffic Mitigation case. However, these levels are improvements over the No-Build case, due to the addition of a right-turning lane on Huntington Avenue westbound. There are no violations of the eight-hour NAAQS in the 1999 Build with Traffic Mitigation case.

In the existing case, the maximum predicted one-hour concentration is 24.8 ppm at receptor 19, the bus stop on Huntington Avenue westbound. The maximum predicted eight-hour concentration is 13.9 ppm at receptor 17, the Budget Rent-a-Car on Huntington Avenue. This value exceeds the 9.0 ppm eight-hour NAAQS by 4.9 ppm.

In 1994, the maximum predicted one-hour concentration is 22.0 ppm, at receptor 19 in the Build case. This value represents a 3.1 ppm increase from the No-Build case. The Build with Traffic Mitigation case shows an improvement over the No-Build case with a predicted concentration of 18.7 ppm at this receptor. This value is a 0.2 ppm improvement from the No-Build case and a 3.3 ppm improvement from the Build case. The maximum predicted eight-hour concentration is 11.5 ppm at receptor 19 in the Build case, a 1.6 ppm increase over the No-Build case. At this receptor, the Build with Mitigation case demonstrates a predicted concentration of 9.5 ppm which is a 0.4 ppm improvement over the No-Build case. The maximum predicted concentration in the mitigation case is 9.6 ppm at receptor 17, a 0.2 ppm improvement over the No-Build case.

In 1999, the maximum predicted one-hour concentration is 20.5 ppm at receptor 19 in the Build case. The corresponding No-Build and Build with Traffic Mitigation concentrations are 17.3 ppm and 17.6 ppm. The maximum predicted eight-hour concentration is 10.3 ppm at this same receptor in the Build case. With traffic mitigation, this value drops to 8.8 ppm; within NAAQS and 0.1 ppm below the No-Build case.

Huntington Avenue/Exeter Street/Stuart Street

Predicted CO concentrations at this intersection demonstrate no violation of the one-hour NAAQS in any study year. In the existing year, however, all five receptors' maximum predicted concentrations exceed the eight-hour NAAQS. In 1994, four receptors in the No-Build case exceed NAAQS. The Build with Traffic Mitigation case demonstrates the levels at three of the four receptors can be improved to meet NAAQS standards.

The maximum predicted one-hour CO concentration is 26.1 ppm, occurring in the existing case at receptor 26, the Copley Place entrance. The maximum predicted eight-hour concentration is 14.1 ppm, under the existing case also at receptor 26. This value represents a 5.1 ppm exceedence of the NAAQS.

In 1994, the maximum predicted one-hour concentration is 20.5 ppm for all three study cases. This occurs at receptor 26. The maximum predicted eight-hour concentration is 10.8 ppm, at receptor 26 in the Build case. Traffic mitigation decreases this predicted concentration to 10.6 ppm; equal to the No-Build case. Mitigation demonstrates improvement over the No-Build case at three receptors and no change at two.

In 1999, the maximum predicted one-hour concentration is 19.8 ppm at receptor 26 in the Build and Build with Traffic Mitigation cases. This value is a 0.1 ppm increase over the No-Build case. The maximum predicted eight-hour concentration is 10.2 ppm at receptor 26 in all cases. The Build with Mitigation case demonstrates improvements over the No-Build case at three receptors and no change at two.

Boylston Street/Dalton Street/Hereford Street

Predicted CO levels at this intersection indicate no violation of the one-hour or eight-hour NAAQS under any case.

In the existing case, the maximum predicted one-hour concentration is 15.6 ppm, located at receptor 31, near the Hynes Convention entrance. The maximum predicted eight-hour concentration is 8.5 ppm, also at receptor 31.

In 1994, the maximum one-hour concentration is 14.2 ppm, occurring at receptors 28 and 30, the Coke machine at the fire station and the restaurant at the Cheri garage. These values represent a 0.9 ppm and 1.2 ppm increase over the No-Build case, respectively. The Build with Traffic Mitigation case shows a 0.2 ppm decrease from the Build case at receptor 28. The maximum eight-hour concentration is 7.2 ppm, occurring in the Build case at receptor 28. This value is a 0.4 ppm increase over the No-Build case. This maximum concentration at this receptor drops to 7.0 ppm in the Build with Mitigation case.

In 1999, the maximum predicted one-hour concentration is 13.7 ppm at receptor 30 in the Build and Build with Mitigation cases, a 1.6 ppm increase over the No-Build case. The maximum eight-hour predicted concentration is 6.8 ppm at receptor 28 in the Build and the Build with Mitigation case. This value represents a 0.5 ppm increase over the No-Build case, however, is well below the eight-hour NAAQS of 9 ppm.

3.6 Mitigation Measures

The Commonwealth's I&M program started on April 1, 1983 and has been assumed in the calculation of motor vehicle emission rates. This program, which results in the overall reduction of yearly motor vehicle emissions, was established to ensure compliance with the NAAQS, on a statewide basis, as outlined in the Massachusetts State Implementation Plan. The attainment and maintenance of the NAAQS for CO in the future is dependent on the continued enforcement of this program.

Other traffic-related mitigation measures to reduce vehicle delays could similarly improve air quality. In general, such traffic-related measures include roadway geometry changes which increase roadway capacities and signal timing optimization which enhances traffic flow.

Specifically for this project, the Build with Traffic Mitigation case was considered at all study intersections based on the transportation reduction measures presented in the Transportation Access Plan (DPIR/EIR Volume III). Some of the mitigation measures utilized are:

- Addition of a lane on Huntington Avenue at the Huntington/Belvidere/ West Newton intersection.

- Restrict parking on the southbound side of Massachusetts Avenue from Huntington Avenue in the PM peak period.

- Improve signage for the southbound left-turn lane on Massachusetts Avenue approaching Columbus Avenue.

- Prohibit all loading and deliveries on Massachusetts Avenue during peak hours.

- Commit the necessary enforcement staff and equipment to ensure the success of the measures.

- Restripe Exeter Street to provide an exclusive left-turn lane, a shared through/left-turn lane, and a right-turn lane.

- Enforce parking regulations to prevent double-parking, particularly along the Exeter Street approach.

- Redefine crosswalks to improve pedestrian safety and reduce pedestrian crossing times.

A complete set of mitigation measures is in the Transportation Access Plan (DPIR/EIR Volume III).

4.0 SOLID AND HAZARDOUS WASTES

The construction of the Prudential Center Redevelopment project will produce demolition debris and require the removal of some hazardous wastes. Upon completion of the redevelopment the amount of solid waste generated by the Prudential Center will increase over existing levels.

4.1 Construction Waste

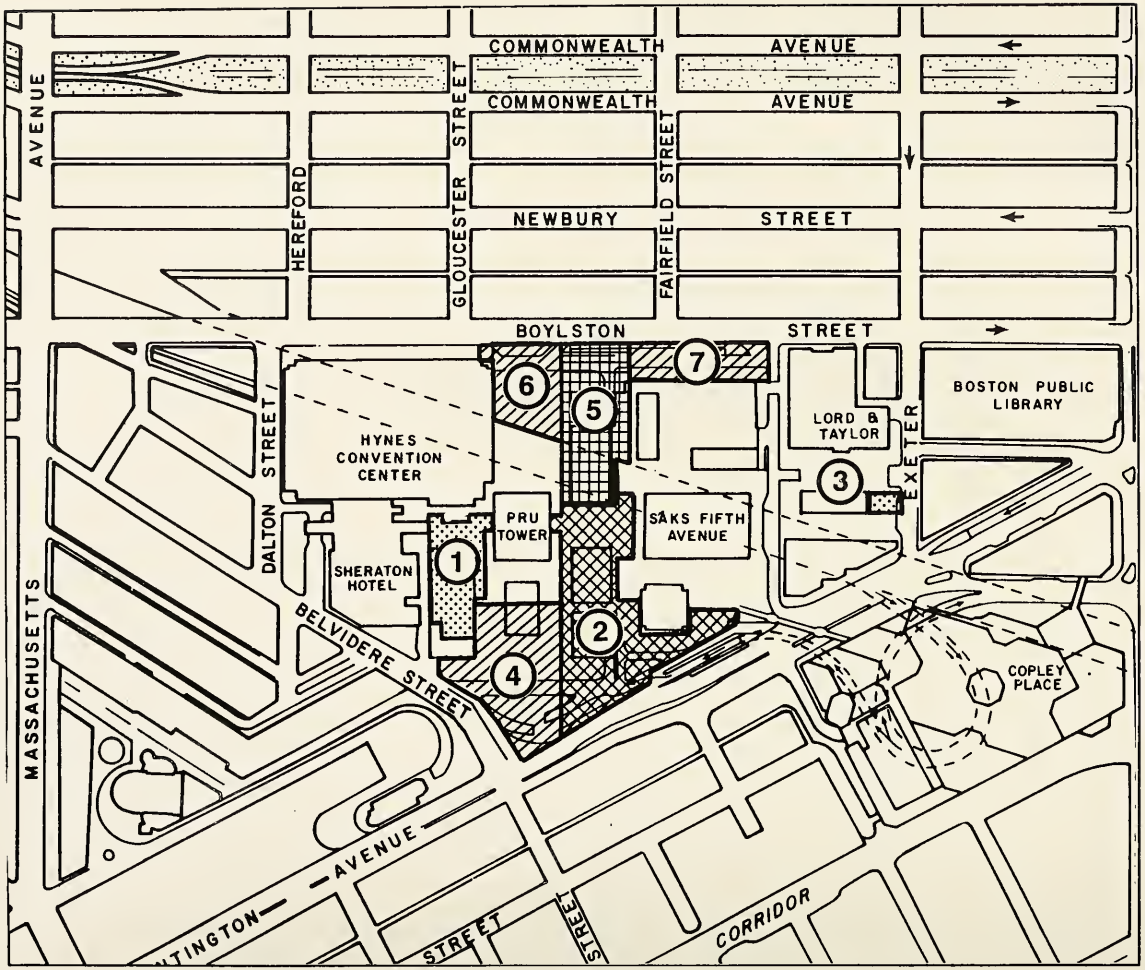
4.1.1 Demolition Debris

The redevelopment project will generate approximately 74,300 cubic yards of demolition debris. The volume of debris was estimated by calculating the debris from the demolition of buildings, decking/garage, infrastructure, and assuming that, at most, 50% of the foundation mat will need to be removed for areas requiring foundation work. Construction debris will consist primarily of non-contaminated steel and concrete in addition to sheet metal, roofing materials, aluminium, glass, and wood.

To accommodate the redevelopment project, some of the existing retail and decking areas will have to be removed. This will include at and below-grade portions of the North and South Ring Roads, the commercial blocks located on the deck, and small sections of three-story parking areas north and south of the Prudential Tower. Demolition proposed for the deck level is shown in Figure IV-22. The approximate volumes of debris will be:

Buildings:	11,700 cubic yards
Decking:	30,600 cubic yards
Infrastructure:	11,300 cubic yards
Foundation Mat:	20,700 cubic yards
TOTAL:	74,300 cubic yards

State-of-the-art demolition techniques will be carried out at the Prudential Center. The exact techniques and methodology are still being developed at this time. A majority of the demolition will be carried out by inserting bolts into sections of the deck or retail areas to be removed, cutting the sections, attaching cables to the bolts and lifting them out with a small crane, commonly referred to as a "cherry picker", and placing it on a truck for transport to a disposal site. Although this technique will not be effective for all demolition, it will be used extensively.



Prudential Center Redevelopment

Fig. IV-22
Demolition Of Deck Level For Each Construction Phase

0 200 400
Scale : feet

4.1.2 Asbestos Removal

The Prudential Property Company, Inc., through its building management contractor, R.M. Bradley, has an ongoing program to remove all asbestos in the Prudential Center. Asbestos is being systematically removed from all buildings as space turns over. At present, 54% of the space in the Prudential Tower and 23% of the space in the 101 Huntington Office building are free of asbestos. In the commercial areas, where some demolition will occur, 69% of the space is free from asbestos. None of the residential apartment buildings contain asbestos.

All asbestos has been removed from garage and infrastructure areas where demolition is proposed. The initial step in each phase of the proposed construction at the Prudential Center will be the removal of remaining asbestos in all areas slated for demolition. A licensed contractor will continue to remove and dispose of asbestos in an approved facility in compliance with pertinent State regulations.

4.1.3 Debris Composition and Disposal Sites

The disposal options for demolition debris depend upon the materials to be disposed of and the current regulatory constraints. Two types of debris will be removed from the site, hazardous and non–contaminated debris. The hazardous debris (asbestos) will be dealt with separately as described in the previous section. There will be additional wastes associated with the roof areas, lighting, and some gas separator pits that require special handling. This debris will be disposed of by a licensed contractor in an approved landfill in accordance with all applicable state and local regulations.

The bulk of the construction debris will consist of non–contaminated steel and concrete. Some of the steel may be salvaged. Concrete waste will be disposed of in an approved landfill under the authority of the contractor. Disposal of debris will be carried out while demolition is occurring to prevent the accumulation of debris on–site. The naming of specific sites for disposal is premature at this time since conditions and available disposal sites may change by the time construction starts. However, the demolition contractor will assume full responsibility for disposing of debris efficiently and appropriately.

4.2 Operational Waste

Once construction is complete, solid waste generated by the Prudential Center will increase as a result of new occupancy of retail, office, and housing areas. This increase has been estimated by projecting current rates of waste generation at the Prudential Center into the future.

4.2.1 Existing Waste Generation

Solid waste currently generated by the Prudential Center is removed by independent contractors from the designated loading areas. R.M. Bradley estimates that the Prudential Center presently generates approximately 4,865 tons of solid waste annually, excluding the Sheraton Hotel. About half of this waste is generated from the office space and the other half from the retail and residential areas. Table IV–3 lists the amount generated from each use. Based on these amounts, a solid waste generation rate per 1,000 square feet per year for each use was calculated. Although the office space generates over half of the waste from the Prudential Center, the rate per 1,000 square feet per year is the lowest. The retail space generates waste at the highest rate, as shown in Table IV–3.

4.2.2 Impacts of New Development

The additional solid waste produced by the Alternative A development is estimated at 2,366 tons per year. This estimate is based on the existing generation rates for each use. Table IV–4 indicates the solid waste generated for each use and the overall projection of solid waste generated from the proposed new development. These are considered to be the most accurate estimates since they are based on actual generation rates for the Prudential Center.

4.3 Current and Proposed Waste Practices

Solid waste generated by the operation of the Prudential Center is removed from the loading areas by independent contractors. This practice will be continued and expanded to accommodate the redevelopment.

TABLE IV-3

SOLID WASTE GENERATED BY THE PRUDENTIAL CENTER*

Use	Area (GSF)	Solid Wastes (Tons/Year)	Estimated Annual Generation Rate (Tons/1,000 sq. ft./yr.)
Office	2,120,000	2,525	1.2
Retail	447,000	910	2.0
Residential	935,900	1,430	1.5
TOTAL	3,502,900	4,865	-

* Based on extrapolation of two months of waste disposal data.

TABLE IV-4

PROJECTED SOLID WASTE GENERATION OF ALTERNATIVE A

Use	Net New Area (GSF)	Estimated Annual Generation Rate (tons/1,000 sq. ft./yr.)	Additional Solid Wastes (Tons/Yr.)
Office	1,009,100	1.2	1,210
Retail	267,800	2.0	536
Residential	404,800	1.5	607
TOTAL	1,688,500	-	2,353

The developer intends to initiate an aggressive recycling program to reduce the projected solid waste. Within the mixed use complex of the Prudential Center, the office sector generates the majority of paper waste. Although the residential and retail components do generate paper waste, the coordination of a paper segregation program for individual tenants is extremely difficult to control, resulting in fewer opportunities for a successful program. The success of a program will depend on the cooperation of tenants and employees, and on aggressive promotions by building management. Individual office tenants at the Prudential Center have taken the initiative to implement their own paper recycling programs with varying degrees of success. No collective program has been pursued to date.

The ideal type of paper recycling program to implement would be one which is coordinated and promoted by R. M. Bradley in connection with overall management of the Prudential Center. This eliminates many of the problems encountered by having individual tenants set up separate programs. The paper segregation program will be implemented as follows:

1) Promotion of Program – The success of a program depends on the cooperation of tenant employees and support from management. It will be necessary to first gain support from management through discussions with each tenant to identify the optimal method for segregating paper wastes.

2) Type of Paper to be Recycled – Once the concept of a recycling program has been discussed with tenants a determination must be made of the specific paper products/types to be recycled. Also, the storage and collection needs and pick–up schedule must be established.

3) Program Implementation/Segregation of Waste – Separate containers will be provided at individual work areas or other designated areas for employees to segregate paper. The large containers will be emptied by the janitorial staff on a daily basis and all recyclable waste will be stored in a separate compactor or container in the loading dock area. These containers will be picked up by a recycling firm on a regular basis.

The developer will perform feasibility studies for the existing Prudential Center during 1989 to determine the most appropriate recycling programs to implement.

5.0 NOISE

An assessment of the potential noise impacts of the Prudential Center Redevelopment consisted of three steps. First, a noise monitoring program was conducted to evaluate the existing noise environment at the Prudential Center. An assessment was conducted for both day and nighttime conditions. This noise level data provided a baseline to assess the compatibility of the existing and proposed residential uses with the existing noise environment, and to determine future noise impacts.

The second step included an investigation of potential construction noise from the redevelopment. The impact of phasing of the overall construction project was examined, including work along Huntington Avenue in Stage I, followed by the work along Boylston Street in Stage II (Stages I and II are described in Section 6.0, Construction Impacts). Impacts of various stages of construction were considered since each stage will utilize a unique combination of equipment and therefore produce different noise characteristics. This analysis is included in Section 6, Construction Impacts.

The third step consisted of predicting and analyzing the post-development noise environment. The potential long-term noise impacts of project generated traffic were estimated and an analysis of the building mechanical equipment noise impacts was undertaken.

5.1 Existing Noise Levels

In order to define ambient noise levels at the Prudential Center, a noise monitoring survey was conducted on March 23, 1988 for daytime hours and on September 21-22, 1988 for nighttime hours. Noise levels were measured for 15-minute periods at a number of locations at the Prudential Center and adjacent to it. The monitoring locations were chosen to reflect areas with the greatest potential for future noise impacts, and places where noise sensitive activities are located. These include locations along the perimeter of the Prudential Center where any increase in peak hour vehicle volumes might raise noise levels as well as open space locations where people may wish to congregate. Standard measurements used to characterize noise levels are:

L_{90} The level exceeded 90 percent of the time, commonly used to describe the lowest, residual, or "background" noise level, below which ambient noise levels rarely fall.

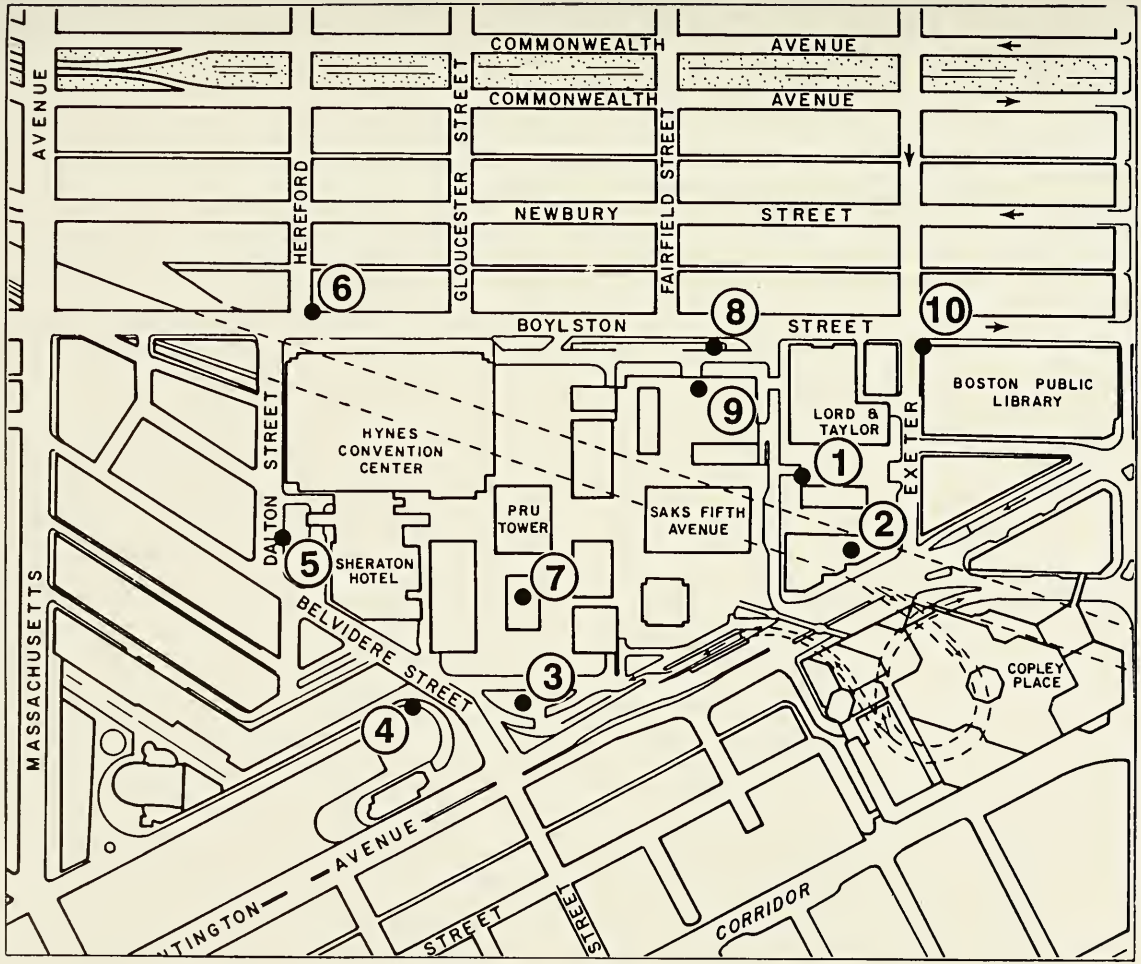
L_{50} The level exceeded 50 percent of the time, commonly used to describe the "average" ambient noise sound level.

L_{10} The level exceeded 10 percent of the time, often used to describe the "near peak", common maximum, or "intrusive" sound levels, such as caused by vehicle passbys.

Figure IV-23 shows the noise monitoring locations. Table IV-5 lists the existing daytime noise levels measurement results.

The data from the noise survey indicates that noise levels on the site and along its perimeter are relatively consistent throughout the day, with the L_{eq} ranging between 60 dBA and 70 dBA. The lowest noise levels were measured in the raised open area adjacent to the Prudential Tower facing Huntington Avenue (Location 7). At that location, the background (L_{90}) level was about 54.5 dBA and the L_{eq} was about 60.5 dBA during the middle of the day. The highest levels measured were at the intersection of Boylston Street and Exeter Street (Location 10), and along Dalton Street by the Sheraton Hotel (Location 5). The L_{90} noise levels at these locations were about 64 dBA and 67 dBA, respectively, and the L_{eq} at both locations was measured at about 69 dBA. The daytime noise levels measured represent levels that are typical of a busy urban environment such as that surrounding the Prudential Center.

The daytime noise levels, in conjunction with nighttime noise levels, provided a representation of ambient noise over a 24-hour period at the site. The average day-night sound level (L_{dn}) was calculated based on the survey results. L_{dn} noise levels are required to determine whether the redevelopment project will be within the noise level criteria established by the U.S. Department of Housing and Urban Development (HUD) for residential developments. The purpose of the HUD guidelines is to encourage the development of land uses which are compatible with the surrounding noise environment. The guidelines also provide policy on the use of noise attenuation measures, where needed. The HUD noise level criteria are listed in Table IV-6. Although the redevelopment project is not a HUD project, the residential noise level criteria are requested by the BRA as a guideline in evaluating whether a site is appropriate for residential development.



Prudential Center Redevelopment

Fig. IV-23
Noise Monitoring Locations

TABLE IV–5
EXISTING NOISE LEVELS (dBA)

Monitoring Location*	L_{90}	L_{10}	L_{eq}
1	59	64	62.5
2	59.5	64.5	62.5
3 (peak hour)**	59.5	65	63
4	59.5	69.5	70.5
5	67	70.5	69
6	60.5	71.5	68.5
7	54.5	62	60.5
8 (peak hour)	61.5	68.5	66
9 (peak hour)	58	63	69
10	64	72	69

* Refer to Figure IV–23 for specific location.

** Measurements were taken during the peak hour of vehicular traffic volumes.

TABLE IV–6
HUD SITE ACCEPTABILITY STANDARDS

	Day–Night Average Sound Level L_{dn} (in decibels)
Normally Acceptable	Not exceeding 65 dB*
Normally Unacceptable	Above 65 dB but not exceeding 75 dB
Unacceptable	Above 75 dB

* Normally acceptable threshold may be shifted to 70 dB in special circumstances.

The noise measurement data indicates that the L_{dn} in the project area is about 66.5 - 67.5 dBA. The HUD criteria establish a normally acceptable criteria for residential uses of 65 dB. However, the criteria allow for an increase in the acceptable noise level to 70 dB for residential uses under certain circumstances. The project falls within this HUD exception, since the project meets:

1) Goals of providing housing in proximity to employment, public facilities, and transportation;

2) The project is in conformance with local goals and maintains the character of the neighborhood; and

3) Other sites which have an L_{dn} of 65 dB or less are generally not available in the City.

It must be noted that the Prudential Center includes existing residential uses as well as additional proposed residential uses. It should also be noted that measured noise levels are at ground level. Noise levels are attenuated with distance, and are, therefore, lower at occupied residential floors which are above the street level. In addition, interior noise levels are attenuated 15 to 25 dBA by the building structure.

5.2 Potential Impacts

5.2.1 Vehicular Noise

Potential long-term noise level increases associated with traffic from the Prudential Center Redevelopment were calculated based on the estimated increase in project-generated traffic over existing conditions. Although existing noise levels in the project area are influenced by a variety of sources, traffic is generally the most significant contributor to local noise levels. Therefore, noise levels measured at locations adjacent to roadways were considered representative of existing traffic noise levels in the project area. The proportionate increases in traffic volumes over existing volumes during future No-Build and Build conditions formed the basis for calculating noise level increases associated with the project.

The volumes for existing, 1999 No-Build, 1999 Build, and 1999 Build with traffic mitigation were compared for roadway segments along Boylston Street, Exeter Street, Huntington Avenue, Belvidere Street and Dalton Street immediately surrounding the project site, and for roadway segments on East Ring Road. The roadway segments analyzed are shown in Figure IV-24. These roadway segments were examined as they are the most significant contributors to traffic-generated noise in the project area.

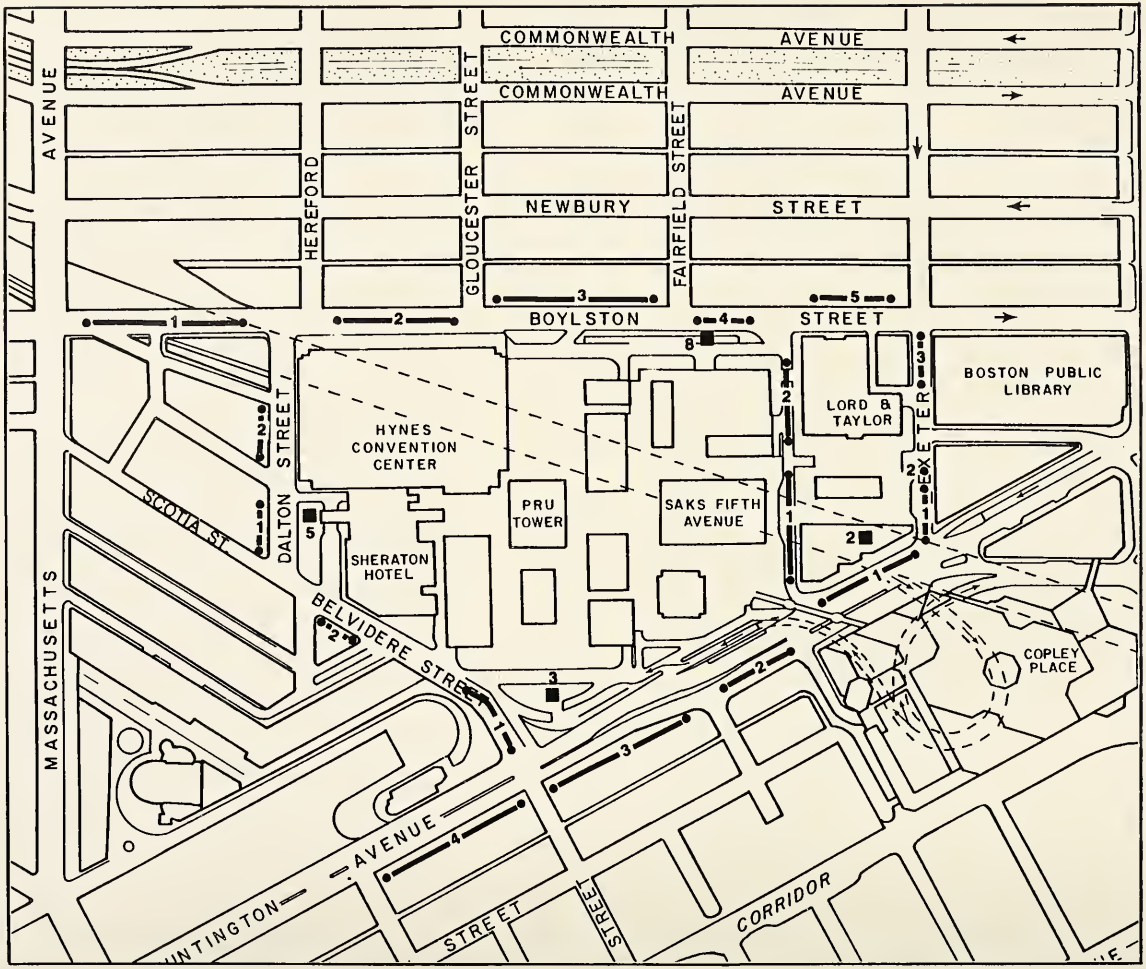
The percent change between existing and No-Build, No-Build and Build, and No-Build and Build with traffic mitigation volumes are summarized in Table IV-7. These traffic volume changes were used to calculate the traffic noise levels changes with and without the proposed project. Under the 1999 No-Build case, peak hour noise levels will increase by a range of less than 1 dBA to 2 dBA without the Prudential Center Redevelopment. Noise level increases of about 1 to 2 dBA at locations 2 and 5 are projected from estimated traffic volume increases along Exeter Street and Dalton Street. Noise level increases of less than 1 dBA are projected at locations adjacent to all other roadway segments investigated in the study area.

In general, 1999 Build peak hour traffic volumes increase in the project area. The highest increase can be attributed to the re-routing of traffic as a result of the closing of the Prudential Center's North and South Ring Roads. All traffic increases associated with the redevelopment project result in increases of about 1 to 2 dBA at locations adjacent to roadways. The differences between the Build and Build with Mitigation traffic noise level are insignificant.

The traffic noise level increases are not considered to be significant changes in noise levels, and would not be perceptible to most people.

5.2.2 HVAC Systems

As is typical of large office buildings, some noise is expected to be produced by the building mechanical systems (heating, ventilation, and air-conditioning; or HVAC). Generally, much of this equipment is hidden in mechanical equipment rooms, above ceilings, or in walls or enclosures. The noise generated by building equipment hidden from view can generally be sufficiently attenuated through the proper use of architectural techniques. Figure IV-25 shows typical noise levels and the effect of attenuation measures. Mechanical equipment for the Prudential Center redevelopment will be located such that sufficient physical and structural separation exists between the equipment and building occupants as well as exterior open spaces and pedestrians. The location and design of mechanical rooms will serve to mitigate potential noise impacts associated with HVAC equipment.



Prudential Center Redevelopment

Fig. IV-24
Roadway Segments Analyzed For Noise Modeling

■ **Monitoring Locations**

(see Fig. IV-23)

TABLE IV-7

PEAK-HOUR TRAFFIC VOLUME CHANGES ON SELECTED ROADWAY SEGMENTS

Roadway Segment	PEAK HOUR TRAFFIC VOLUMES (% CHANGE) Existing to 1999 No-Build	1999 No-Build to 1999 Build	1999 No-Build to 1999 Build Mitigate
BOYLSTON STREET			
1	4.3	2.2	2.0
2	18.0	3.2	2.3
3	14.6	11.6	11.0
4	8.3	36.5	33.6
5	16.7	11.2	7.0
DALTON STREET			
1	8.1	8.4	5.4
2	36.2	9.7	7.8
BELVIDERE STREET			
1	11.5	21.6	14.1
2	6.7	8.0	4.9
HUNTINGTON AVENUE			
1	6.0	2.0	1.4
2	11.7	15.5	14.7
3	9.7	22.4	20.7
4	6.9	5.7	3.8
EXETER STREET			
1	27.1	8.7	5.4
2	14.1	1.8	1.5
3	10.0	0.9	0.9
4	2.5	1.2	1.2
EAST RING ROAD			
1	18.0	4.3	2.9
2	19.1	-43.7	-47.2

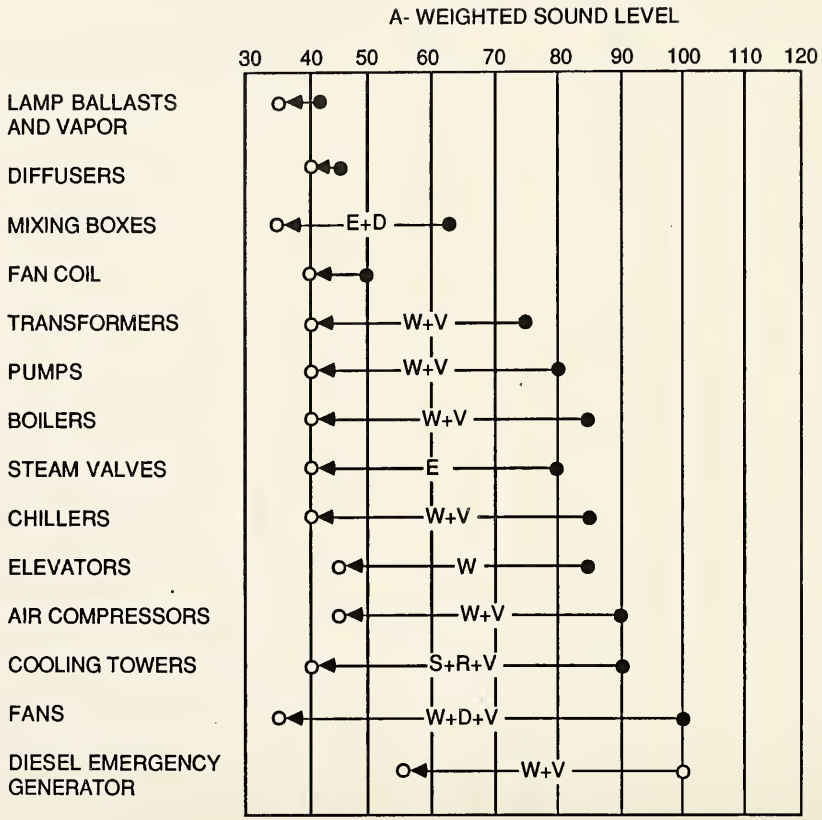


Fig. IV-25 Range of Building Equipment Noise Levels to Which People Are Exposed

Architectural plans for the redevelopment have not progressed to the point where the locations of mechanical systems are known. As a design criteria, all exterior equipment, such as intakes and exhaust vents, will be located far enough away from outdoor open areas to allow for attenuation of HVAC noise to background levels.

5.3 Mitigation Measures

In summary, locating retail stores in the lower two floors of the new residential buildings will reduce the noise environment on the residential apartments by raising the apartments from the noise sources located at street level. Additional design measures, to limit noise levels in the new buildings resulting from a busy urban environment, can be incorporated. Energy conservation measures, such as double-glazed windows and appropriate amounts of insulation in the walls, also attenuate interior noise levels by up to 35 dB.* Appropriate noise attenuation measures will be incorporated in the new residential structures as the design process progresses. The new buildings will also act as a noise shield between street level noise sources and existing residential buildings, thus improving the noise environment at these existing buildings.

The additional traffic noise from the new development will be insignificant when compared to noise levels without the project. Necessary steps will be taken in the design of all the new buildings to eliminate impacts of building mechanical noise.

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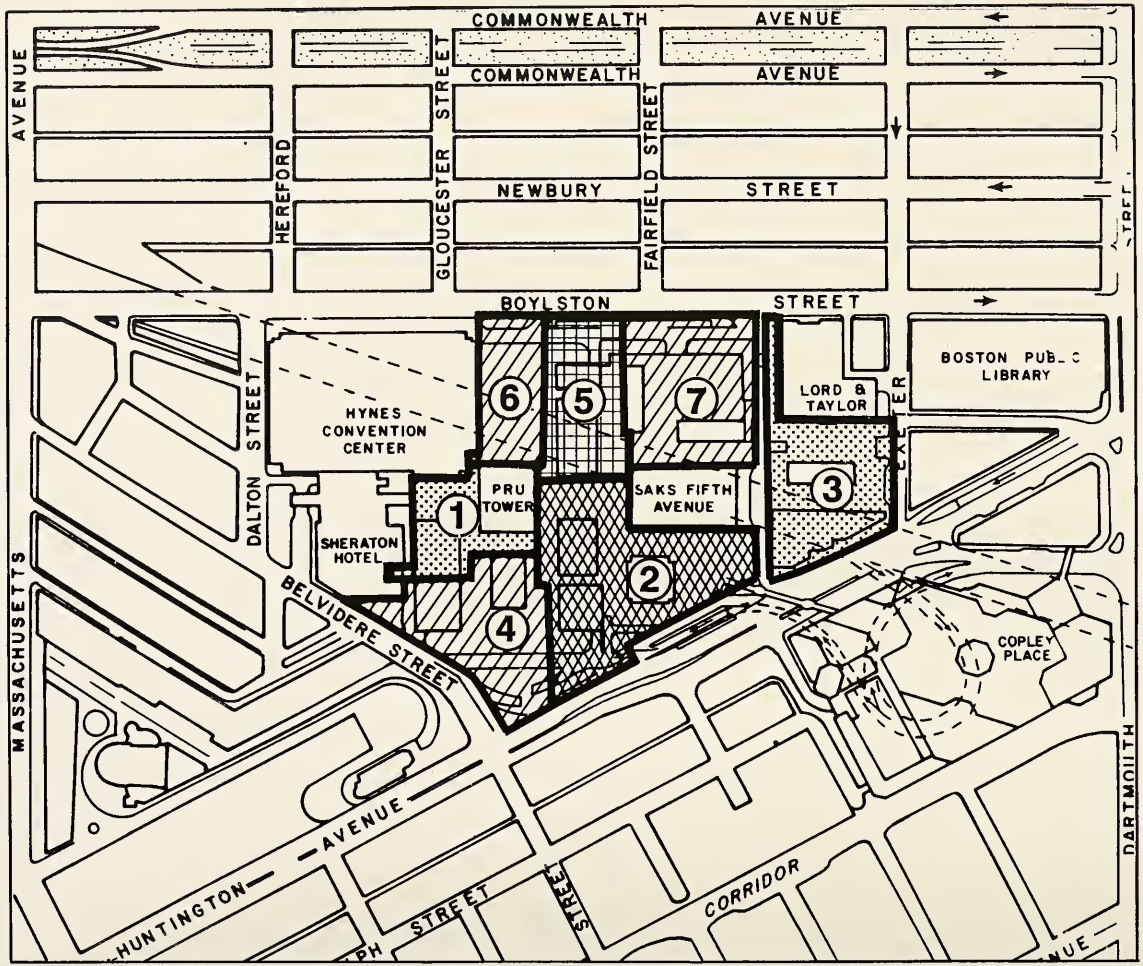
* SOURCE: Egan, M. David. 1988. Architectural Acoustics. McGraw Hill.

6.0 CONSTRUCTION IMPACTS

The information in this section is based on current construction planning of a generalized level, appropriate to the current master planning stage. The construction impacts and management techniques described in this section are based primarily on Alternative A but are generally applicable to all alternatives. As plans become more precise, there will be consultation with public agencies and representatives of local businesses concerned with construction management. The master planning construction impact analysis and management plans described in this section detail known impacts along with general construction management techniques that will be applied. When a development Alternative is selected for the site, more detail will be developed. During the more detailed phase of construction planning, the construction consultant will meet with the Boston Transportation Department and the Boston Public Works Department to design an acceptable Construction Management Plan prior to application for a building permit. Significant effort has been made to address the concerns of each constituency at the Prudential Center in building this complex project.

The developer has held meetings with the Prudential Center Project Advisory Committee (PruPAC), composed of local representatives, to receive input and to answer questions about the project and its construction. The developer is committed to regular meetings with affected parties, including City agencies, neighborhood and on-site residents groups, key office tenants, and the Merchants Association.

The proposed construction process for the redevelopment project is expected to last approximately six to seven years. This estimate does not include the design and lease-up phase of the redevelopment. Construction will be conducted in phases which will limit the impacts on the surrounding environment. Phases 1, 2, 3, and 4 (Stage I) will be on the south side of the Prudential Center along Huntington Avenue, Belvidere Street, Exeter Street and East Ring Road. These phases will include a pedestrian way into the Prudential Center from the Copley Place Bridge, retail areas on the south side of the site, a neighborhood commercial center, a food court, a daycare center, open space and two office buildings. Phases 5, 6, and 7 of development (Stage II) will take place along Boylston Street and will involve retail areas, residential buildings, open space, and an office building. Figure IV-26 shows the location of each phase.



Prudential Center Redevelopment

Fig. IV-26
Alternative A
Construction Phasing

Stage I,
Phases 1,2,3,&4

Stage II
Phases 5,6,&7

6.1 Construction Activity Schedule

The proposed construction process for the redevelopment project is expected to last approximately six to seven years. This estimate does not include the design and lease-up phase of the development. The construction will be completed in phases to limit the impacts on the surrounding environment. Typical construction hours for this project will be from 7:00 AM to 3:30 PM Monday through Friday.

6.1.1 Construction Phases

The following is the best estimate at a master plan level of detail of the timing of the major steps for each of the project phases and their likely impacts based on Alternative A, which is the most extensive alternative. The steps of construction for each phase overlap as shown in the construction schedule (Figure IV-27); an overall estimate of the duration of the construction of each phase is included below. Figure IV-26 shows the location of each phase. The schedule will be flexible enough to adjust to market conditions so these phases will not necessarily occur sequentially.

Phase 1 - Food Court

Phase 1 will consist of a food court, one-story retail areas, and open space with landscaping next to the Prudential Tower east of the Sheraton Hotel. It will take approximately 22 months to construct. Pedestrian access through and around the site will be provided throughout construction of this phase. The following activities will take place:

- Asbestos Removal - Any remaining asbestos will be removed from the existing retail structures over a two to three-month period. The work will be interior so the only significant noise source will be trucks moving in or out of the project site. The asbestos removal process is described in Section 4.1.2.

- Demolition - This activity will take two months. The demolition will be primarily accomplished by cutting and removing the retail areas, as described in Section 4.1.1.

- Support Structure Preparation – This will take about two months. The work will consist of placing concrete and laying supports on the existing deck. There will be no deep foundation work. The traffic impacts that result from trucks bringing concrete to the site will be minimized by dispatching trucks by radio from their origin as needed.

- Frame and Floor – This will take two or three months. The major noise impact will result from pneumatic tools, cranes, and other mechanical equipment. Trucks bringing in the steel and placement of the beams will generate some noise.

- Exterior Cladding/Interior Finish – This will take eight to nine months. This activity involves installation of the building's exterior cladding and partitioning of the interior space. Some noise and traffic impacts will result from delivery vehicles and movement in and out of the site.

- Tenant Fit-Up – This will take about eight months. It will consist of interior work and the primary impact will be noise from truck traffic.

Phase 2 – Huntington Office Building

This phase consists of a 22-story office building and the retail areas from the Copley Place bridge to the food court. The retail areas will be constructed in a similar way to Phase 1. This work will complete a pedestrian walkway from Copley Place to the Food Court/Hynes Convention Center. The Huntington Office building will take approximately 32 months and will consist of the following activities:

- Asbestos Removal – Any remaining asbestos will be removed from the existing retail structures to be demolished over a five to six-month period. The work will be interior so the only significant noise source will be trucks moving in or out of the project site.

- Demolition – This activity will take eight months. In addition to the steps described in Phase 1 demolition, the office structure foundation will require removal of the deck and garage levels as well as the concrete foundation mat for the deep pile foundations of the office building. The primary work will be cutting and removing the concrete and steel. The primary impacts during this period will be noise from equipment on–site, dust from demolition operations and traffic from trucks moving into and out of the site.

- Foundation – This activity will take seven to eight months. The office structure will be supported on end bearing piles. The piles will be pre–augered entirely through the clay stratum to a depth of about 110 feet. Only the last 10 to 15 feet of the piles will be driven. Noise will result from such pile driving but since the piles will be pre–drilled, the overall noise impacts will be moderate. Retail areas will be built on the existing deck and thus, only require support structure work.

- Frame and Floor – Core and shell will take about seven to eight months. The major impact will result from pneumatic tools and other mechanical equipment. Trucks bringing in the steel and placement of the beams will generate some noise. A climbing tower crane will be employed. This will have the effect of moving the engine noise away from street level as the job proceeds and will reduce staging requirements.

- Exterior Cladding/Interior Finish – This activity will take about 12 months and will involve installation of the building's exterior cladding. The use of the climbing tower crane will be required. Moderate noise and traffic impacts will result from delivery vehicles and movement of materials in and out of the site.

- Tenant Fit–Up – This activity will take about 12 months and will consist of interior work in the office and retail/common areas. The primary impact will be noise from truck traffic.

Phase 3 – Neighborhood Commercial Center/Child Care Center

This will consist of building a contemporary supermarket, local shops, and a child care center in the southeast corner of the Prudential Center. This will be completed early in the overall construction process and prior to the demolition of the space occupied by Star Market on Boylston Street. Phase 3 will take approximately 17 months and will consist of the following activities:

- Demolition – This activity will take two months and will involve work on the deck level only.

- Support Structure Preparation – This work, which will take about two to three months, will all be done on the existing deck to avoid impacts on the turnpike and rail easements. This work will consist primarily of placing concrete and laying supports on the existing deck. The major impacts will be traffic from the truck deliveries.

- Frame and Floor – This activity will take about two to three months. The major impact will be noise resulting from pneumatic tools, trucks bringing in steel, and cranes.

- Exterior Cladding/Interior Finish – This activity will take about eight to nine months. Some noise and traffic impacts will result from work on the buildings and delivery of supplies.

- Tenant Fit-Up – This activity will take about six to seven months. This will consist of the tenants completing interior work on the retail space. The primary impact will be noise from truck traffic.

Phase 4 – Belvidere Office Building

This will consist of an 11-story office building on the corner of Belvidere Street and Huntington Avenue. The impacts on the environment will be of the same nature as those from Phase 2, but for a shorter duration since this building will be approximately half the size of the Huntington Office building. Demolition will take approximately six months;

foundation work will take six months; frame and floor work will take seven months; exterior cladding/interior finish work will take 11 to 12 months. Tenant fit-up will take about 11 to 12 months. Piles will be pre-augered and a climbing tower crane will be used to reduce potential noise impacts and minimize staging requirements. The overall duration of construction will be about 22 months.

Phase 5 - West Boylston Residences

This will be one of three phases of development on Boylston Street. It will consist of a residential building on Boylston Street with a retail area behind the building. A pedestrian walkway, cutting north-south through the site, will be completed in this phase. This phase will take approximately 30 months and will consist of the following activities:

- o Asbestos Removal - Any remaining asbestos will be removed from existing retail structures to be demolished over a five-month period. As with other asbestos removal, the work will be interior so the only significant noise source will be from trucks removing debris.

- o Demolition - This activity will take approximately five to six months. The primary work will be cutting and removing steel and concrete. The impacts will be the same as for the demolition work carried out in earlier phases.

- o Foundation - Foundation work will consist of foundation work for the residential structure which will be carried out in the same manner as earlier deep foundation work and will take about five or six months. Noise impacts will be minimized by pre-augering piles for the deep foundations.

- o Frame and Floor - This activity will take about seven months. The use of a climbing tower crane will limit noise and staging requirements.

- o Exterior Cladding/Interior Finish - This work will take about 12 to 13 months and will involve installation of the building's exterior cladding which requires the use of the climbing tower crane. Noise and traffic impacts will result from the installation of the cladding.

- Tenant Fit-Up – This activity in the new retail space will take approximately six to seven months. The primary impact will be truck traffic.

Phase 6 – Boylston Office Building

Phase 6 includes an office building and retail areas. The steps involved in the construction of this phase will be similar to those of Phases 2 and 4. The smaller scale of the Boylston Office building, compared to the Huntington Office buildings in Stage I, will result in impacts for a shorter duration. The overall construction will take 31 months. The demolition will take seven months; the foundation work will take seven months; the frame and floor work will take four months; and the exterior cladding/interior finish work will take 11 months. Tenant fit-up of the retail areas will take about 7 months.

Phase 7 – East Bolyston Residences

This phase will consist of the second portion of the Boylston Street residences. The work will be similar to Phase 5 with much less retail work. The work will take 22 months and consist of the following steps:

- Demolition – This activity will take approximately five to six months. The primary work will be cutting and removal of steel and concrete. The impacts will be the same as the demolition work carried out in other phases.

- Foundation – This activity will take about five months. The structure will be supported on a deep foundation of end bearing piles. The piles will be pre-augured rather than driven through the clay stratum to a depth of about 120 feet. Only the final 10 to 15 feet will be driven. Noise will result from the pile driving but the piles will be pre-drilled to reduce the overall noise levels.

- Frame and Floor – This activity will take about seven months. The major impact will result from pneumatic tools and other mechanical equipment. Trucks bringing in the materials will generate moderate noise levels. A

climbing tower crane will be employed which will have the effect of moving the engine noise away from street level as the job proceeds and minimizing staging requirements.

- Exterior Cladding/Interior Finish – This activity will take about 12 months and will involve installation of the building's exterior cladding. A climbing tower crane will be used for this work. Some noise and traffic impacts will result from delivery vehicles and movement in and out of the site.

- Tenant Fit-Up – This activity in the new retail space will take approximately three months. The primary impact will be truck traffic.

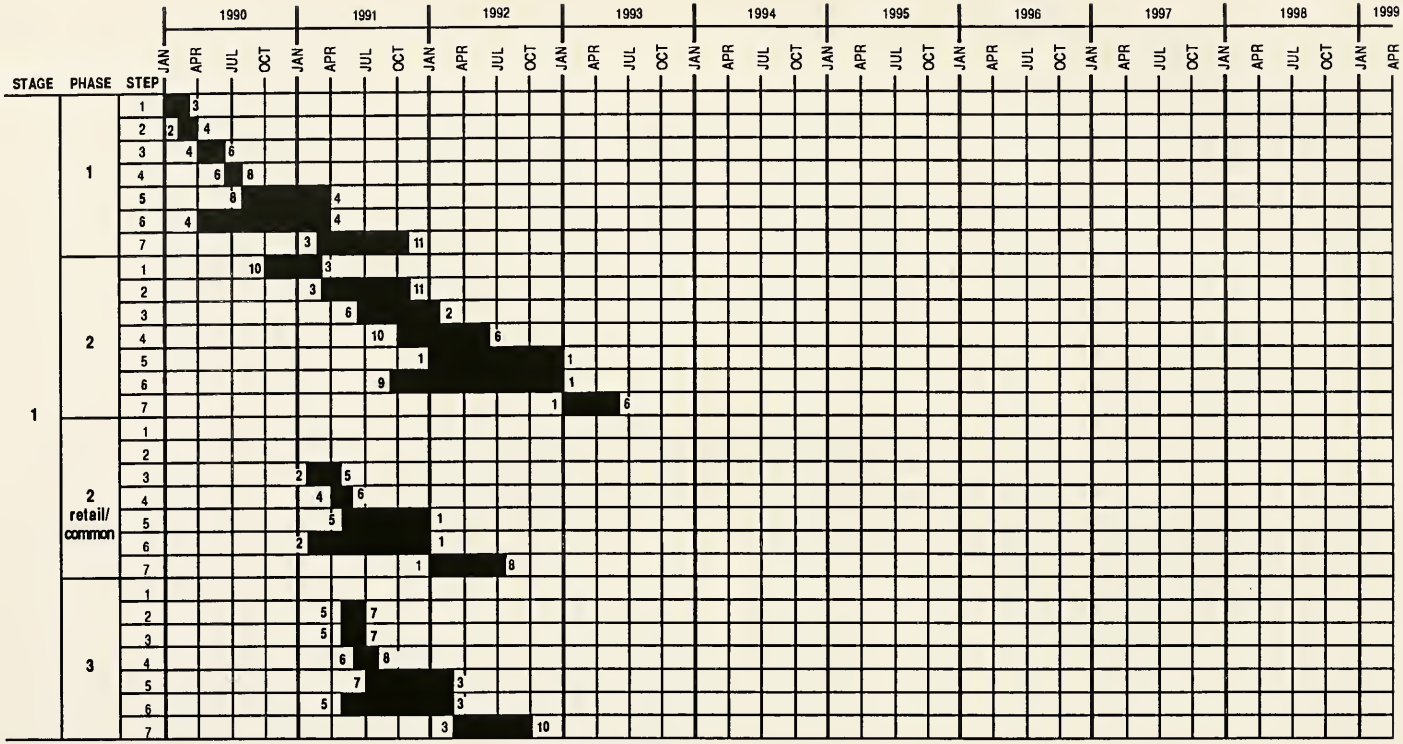
6.1.2 Construction Schedule

The construction schedule shown in Figure IV-27 reflects the project phasing and time frame anticipated. Overlap of the phases will influence some of the construction impacts. Due to market conditions and other factors, the phases will not necessarily be constructed in numerical order. The construction duration and the timing of each phase will be subject to adjustment.

6.2 Construction Noise Impacts

Construction activities will result in the creation of temporary noise and vibration impacts, as a result of the operation of construction equipment on-site and traffic to and from the construction site. Actual noise levels will depend on such factors as the location of the work and the choice of equipment used. Noise generated by construction truck traffic will be temporary and variable in nature. To a large extent, this noise will be masked by high ambient noise levels.

The construction noise impacts were analyzed using noise level measurements made at other construction sites in Boston. The results of acoustical measurements taken during concrete placement, steel erection and exterior cladding and finish work at three construction site in Boston are shown in Table IV-8. In discussing noise levels, the common A-weighted decibel (dBA) is used. The A-weighting refers to a standard frequency weighting that most accurately approximates human hearing.



STEP 1- Asbestos removal
STEP 2- Demolition
STEP 3- Foundation work *
STEP 4- Frame / Floors
STEP 5- Exterior cladding / Interior finish
STEP 6- Mechanical / Electrical
STEP 7-Tenant fit-up
* For PHASE 1, 3, and any retail / common areas STEP 3 is Support Structure Preparation only

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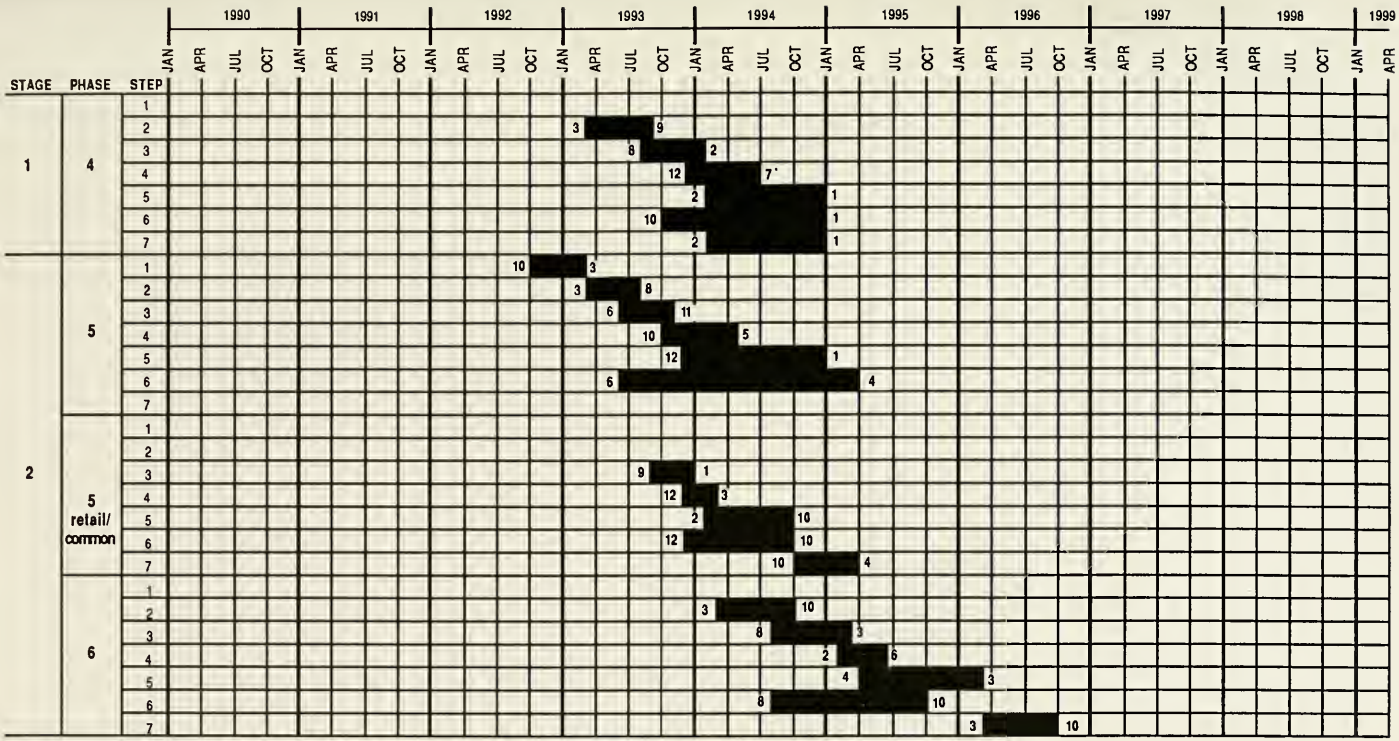
NOTE:
NUMBERS INDICATE MONTHS OF THE YEAR.
ALL STEPS BEGIN AND END ON THE 1ST OF THE MONTH.

Fig. IV-27
Construction Schedule



STEP 1- Asbestos removal
STEP 2- Demolition
STEP 3- Foundation work *
STEP 4- Frame / Floors
STEP 5- Exterior cladding / Interior finish
STEP 6- Mechanical / Electrical
STEP 7-Tenant fit-up
* For PHASE 1, 3, and any retail / common areas STEP 3 is Support Structure Preparation only

Fig. IV-27 (continued)
Construction Schedule

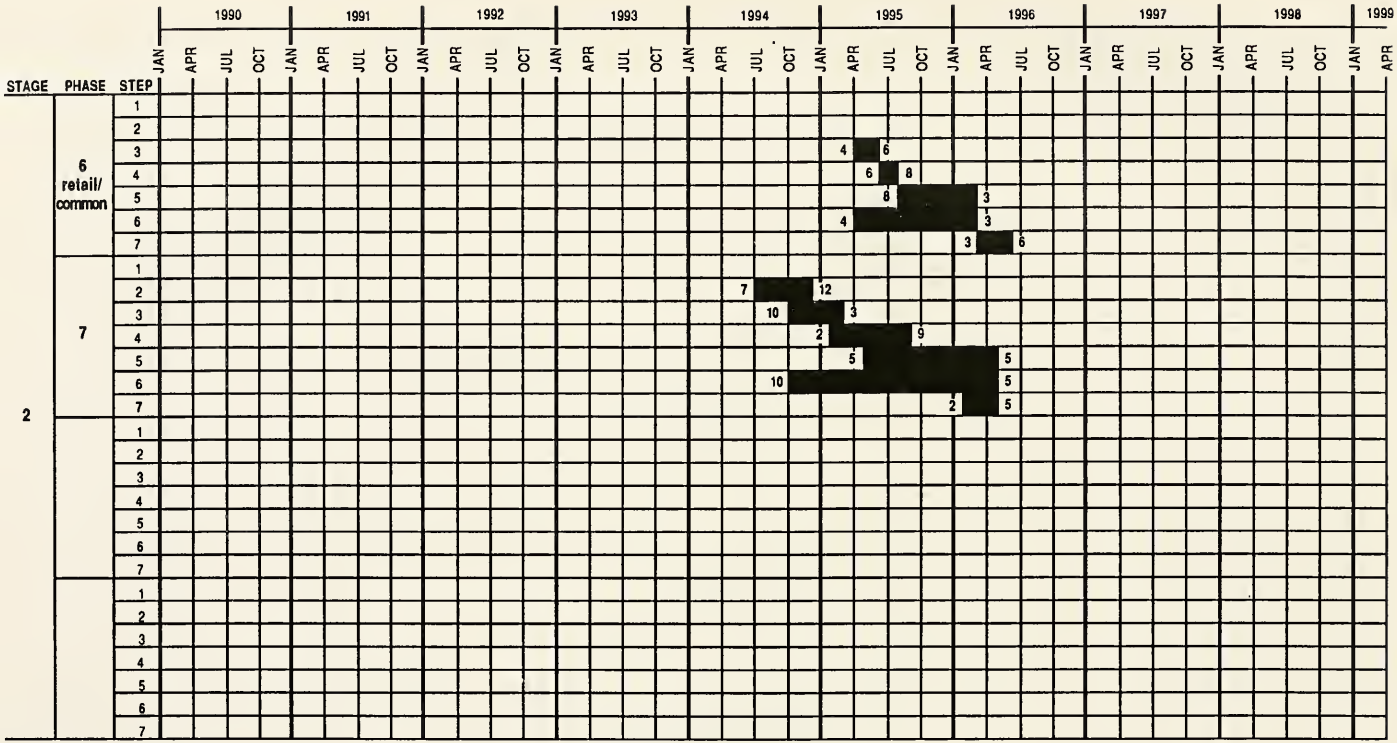

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TABLE IV-8

NOISE LEVELS OF TYPICAL BOSTON CONSTRUCTION ACTIVITIES

Activity	Noise Levels (dBA)			Major Noise Sources
	L10	L50	L90	
Concrete Placement	81	78	73	Crane motor, some sawing Background: traffic
Steel Erection	86	77	74	Impact hammering, trucks
Exterior Cladding and Finish Work	76	67	64	Traffic Background: traffic (Note: construction activities rarely audible.)

NOTES: All measurements made between 2:30 and 3:30 PM, September 17, 1986, using GenRad Type 1933 Precision Sound Level Meter (ANSI S1.4-1984 Type "1"). Meter field-calibrated before and after measurements. All measurements reported in dBA, re: 20 micropascals. All dBA numbers represent noise levels 50 feet from the construction site perimeter.

The City of Boston noise regulation for construction activity sets the maximum allowable noise levels at the lot line of adjacent properties affected by construction noise. The regulations include a maximum allowable instant noise level and a peak noise level that should not be exceeded ten percent of the time (L_{10}) for various land uses. The maximum L_{10} noise level of 80 dBA for business uses will generally apply in and around the Prudential Center. To assess potential construction noise impacts on apartments in the area, the lower residential standard of 75 dBA is applicable. Table IV–9 presents the City's construction noise level regulations.

6.2.1 Construction Noise Levels

During demolition at the Prudential Center, retail areas and deck sections will be removed. Debris will be hauled away concurrently with demolition. The construction noise from demolition will primarily result from the equipment used to cut concrete, cranes removing concrete sections, and trucks hauling debris. Noise levels during demolition are expected to be in the 80 dBA to 85 dBA range. No noticeable incremental increase in the overall traffic noise levels in the area is expected to result from project–related vehicular or truck traffic.

During foundation work, noise will be created during placement of piles for the deep foundations. In areas where deep foundations are not required, the deck support structure will require concrete work. Foundation work will generate truck noise from deliveries of concrete and steel, however, these will not greatly influence existing noise levels. Noise levels associated with deep foundation construction will be greatly mitigated by pre–augering each pile location for 100 feet and only driving the piles the remaining 10 to 20 feet.

The steel erection is expected to increase noise levels in the surrounding area. A climbing–tower crane will be used during steel erection. During this phase, noise levels are expected to range from the upper 70s to low–80s dBA at a distance of 50 feet from the construction site boundary.

During the exterior shell and finish work, construction noise impacts are expected to be less than steel erection.

TABLE IV-9

CITY OF BOSTON

SUMMARY OF RESTRICTIONS ON CONSTRUCTION SITE NOISE*

3.1 Maximum Levels

Affected Property	Maximum Noise Level Value Measured at Lot Line of Affected Property (dBA)	
	L_{10}	Maximum Noise Level
Residential or Institutional	75	85
Business or Recreational	80	-
Industrial	85	-

(To be evaluated at distances not closer than 50 feet from nearest active construction device, using slow response of sound level meter.)

3.4 Maximum levels under 3.1 do not apply to impact devices (pile drivers, paving breakers, riveters, etc.).

* City of Boston Air Pollution Control Commission, "Regulations for the Control of Noise in the City of Boston". Regulation 3, Effective January 1, 1976.

6.2.2 Potential Noise Impact Analysis

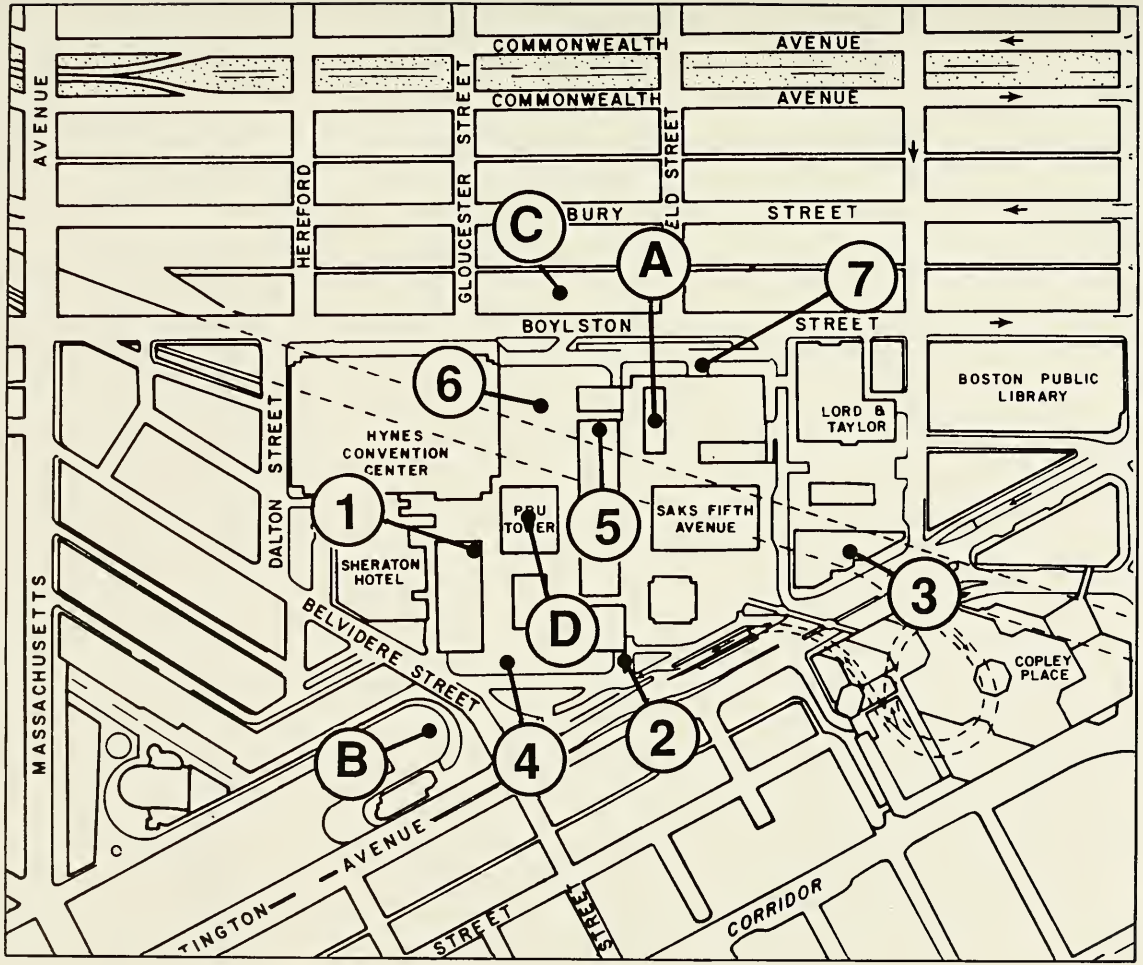
The existing urban noise levels at the Prudential Center will help mask the noise due to construction. Some of the noise associated with construction result from trucks used both to haul away demolition debris and to bring building materials and construction equipment to the site. Noise from these trucks will tend to be masked by the existing vehicular and truck traffic noise in the area, and should not be noticed as an increase in the overall levels of traffic noise. Noise impacts will be noticeable from actual construction activities on-site. These impacts were modeled for residential, office, and pedestrian use categories.

Methodology

In order to determine construction noise impacts at each receptor, noise levels expected from each phase were defined according to data presented in Table IV-8. For modeling purposes, a single "activity center" was selected to represent the location from which construction noise is emitted. Figure IV-28 shows activity center locations for each of the 7 phases of construction. The next step was to select receptor locations. Locations were chosen to represent sensitive land uses, both before and after construction, and areas where construction activities would result in peak impacts. A total of four receptors were modeled. At a master plan level of analysis, maximum construction noise was modeled by finding which activity center will impact each receptor. The activity center closest to a sensitive receptor will most likely control the peak noise levels at the sensitive receptor. Therefore, the peak noise levels from the closest activity center are used to predict noise levels at a sensitive receptor. The sensitive receptors (A through D) and construction activity centers (1 through 7) are shown on Figure IV-28.

Receptor A is the Fairfield apartment building. This receptor was selected to represent an on-site residential use area. It was chosen over the Boylston and the Gloucester apartment buildings because it is closest to locations where major structures are planned (Boylston Street residential buildings). Thus, it will be subject to noise emissions from foundation, superstructure, and shell/finish phases of construction.

Receptor B is the Christian Science Plaza and is used to evaluate potential impacts on users of this open space.



Prudential Center Redevelopment

Fig. IV-28
Construction Activity Centers And Location of Sensitive Receptors

(1) Activity Centers
(A) Sensitive Receptors

Receptor C is located on the north side of Boylston Street. This location was selected to represent off-site office and commercial use impacted by construction along Boylston Street. These impacts are representaive of those that will be experienced opposite Huntington Avenue.

Receptor D, the Prudential Tower, was selected to represent on-site office use. Construction noise levels at the Tower are representative of those at 101 Huntington Avenue as well.

Results of Impact Analysis

Residences

Of the three apartment buildings at the Prudential Center, noise impacts are expected to be greatest at the Fairfield apartment building. Activity Centers 1 through 4 will not significantly affect noise levels at this building. The L_{10} noise level will be influenced most by Activity Centers, 5, 6 and 7. The highest noise levels will be experienced when the maximum steel erection work takes place in Phase 5, due to impact hammer use.

Peak noise levels will be experienced when steel erection work for the Phase 5 office building is underway since it is closest to the Fairfield. Fortunately, steel erection for the retail structures in Phase 6 does not overlap with steel erection of Phase 5. Peak noise levels at the Fairfield are not expected to be controlled by Phase 7 work since the super structure of this phase will be concrete instead of steel. Noise levels associated with short-term construction of low-level infill abutting each building may result in noise levels higher than those associated with the longer term construction phase of major structures. The highest L_{10} noise levels will reach about 82 dBA at the exterior boundary of the Fairfield apartment building. Noise levels experienced by persons inside the building will be, on average, 25 dBA lower.*

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* Protective Noise Levels, EPA Office of Scientific Assistant to DAA/Noise, November 1978.

Office Workers

To assess possible impacts of construction noise on office workers the noise levels expected outside the Prudential Tower were modeled. Noise levels experienced at 101 Huntington will be similar to those predicted at the Prudential Tower. The loudest construction noise levels, which will be experienced in the offices on the lowest floors of the Prudential Tower, are expected to be from Phase 1.

Noise levels from concrete placement may reach an L_{10} of 76 dBA. During steel erection, when the louder impact tools are being used, the L_{10} noise level may reach a peak of 86 dBA when abutting infill structures are under construction. This will be for a short duration, however. More typically, an L_{10} of 80 dBA will be experienced. The quietest L_{10} noise level of 70 dBA is expected from the siding and finish work. None of these levels exceed the City's standard of 80 dBA for commercial areas. The noise levels inside the offices will average 15 to 25 dBA lower, and offices on higher floors will experience less noise.

At the receptor analyzed across Boylston Street, noise levels are expected to peak at 78 dBA during steel erection work at Phase 6.

Pedestrians

The impacts of the construction noise on the Christian Science Plaza were evaluated to assess possible impacts on pedestrians. The highest noise impacts will be during Phase 4 construction activities. The L_{10} noise levels will most likely fall in the lower 70's during concrete placement to the upper 70's dBA during steel erection. During lunch time, when most use is expected of an open area like the Plaza, construction work will typically diminish around noon and noise levels will decline. General pedestrians traffic will experience the construction noise for only the brief period of time it takes to walk past or through the Prudential Center.

6.2.3 Construction Noise Mitigation Measures

High ambient noise levels currently around the site will, in part, mask the temporary increases in noise levels during construction at the Prudential Center. There are a number of potential measures which could be taken to further mitigate the construction noise generated from the redevelopment project, including:

- Use of appropriate mufflers.
- Installing enclosures around the work area where stationary equipment is being used.
- Replacement of individual operations and techniques by less noisy ones – e.g., mixing concrete off–site instead of on–site.
- Selecting the quietest of alternative items of equipment – e.g., electric instead of diesel–powered equipment.
- Turning off idling equipment.
- Keeping noisy equipment as far as possible from sensitive areas.

6.3 Construction Staging Areas

Staging areas for each phase of the redevelopment will be located to ensure safe and efficient construction with a minimum of disruption to the Prudential Center and surrounding areas. The staging plan is designed to isolate the construction while providing safe access and egress for pedestrians from buildings in the Prudential Center for normal operations and in emergencies. Preliminary master plan level staging plans based upon Alternative A are discussed herein. More details will be developed and presented in the Construction Management Plan as plans progress.

Provisions for delivery and storage of construction materials and equipment are described. A key element to the plan is the provision of off–site staging areas. These will be set up to limit storage of construction materials at the Prudential Center. The location of off–site staging areas depends upon the types and origin of construction materials and locations of the contractors. Consequently, the precise locations have not been identified at this point.

The construction will require the reconfiguration of the access and egress ramps from the Prudential Center garage. Garage access and egress issues are discussed in the Prudential Center Redevelopment Transportation Access Plan (DPIR/EIR Volume III). In addition, potential impacts on the surrounding roadways are briefly discussed here and in more detail in Volume III of the DPIR/EIR.

For each phase of construction, initial plans have been developed to provide for:

- o Perimeter Protection;
- o Pedestrian Access;
- o Construction Material Handling;
- o Emergency Egress; and
- o Traffic Rerouting.

These are described in the following paragraphs.

Phase 1 – Food Court

Perimeter Protection

Fencing and partitions will be installed around the perimeter of the site. A corridor of fencing will extend from the construction area to South Ring Road, along the edge of the open space south of the Prudential Tower, and around a construction loading dock on the sidewalk adjacent to South Ring Road creating a protected materials handling route.

Pedestrian Access

Inside the Prudential Tower, partitions and signage will be set up to direct pedestrians around the construction activity. Pedestrians will be diverted to the south side of South Ring Road, around the construction loading dock area. Within the construction site, pedestrian access will be maintained to the Prudential Tower, the Hynes Convention Center, and the Sheraton Hotel.

Construction Material Handling

Truck delivery of construction materials will enter and depart Phase 1 from South Ring Road where the main loading dock for this phase will be located. A crane will be located at the loading dock to transfer materials to and from the higher deck elevation. The material will be handled by smaller trucks and cranes at the higher deck level. Materials needed for this phase of the redevelopment will be stored at deck level within the construction perimeter and at off-site storage areas.

Emergency Egress

Emergency egress will be provided from the Prudential Tower, Hynes Convention Center, and the Sheraton Hotel using existing exits to walkways through the construction site or approved alternate egress routes will be developed. Fire department access to the Phase 1 area will remain unchanged over the plaza from South Ring Road.

Traffic Rerouting

No major traffic rerouting is anticipated for Phase 1. The Construction Management Plan will completely discuss any necessary traffic rerouting for this phase of the redevelopment project.

Phase 2 – Huntington Office Building

Perimeter Protection

Fencing and partitions will enclose the construction site and construction loading docks located on South Ring Road, adjacent to East Ring Road, and Huntington Avenue.

Pedestrian Access

During extensive portions of the Phase 2 construction period, sidewalks immediately adjacent to the foundation of the proposed building will be closed to protect pedestrians. Pedestrian access through the site will be maintained between the Copley bridge, 101 Huntington, Saks Fifth Avenue, and the Prudential Tower. The location and configuration of these pedestrian routes through the site will shift as construction progresses.

Construction Material Handling

Truck deliveries of construction materials will enter and depart the construction site at loading areas at South Ring Road, East Ring Road, and Huntington Avenue. Storage of construction materials will be at the deck level within the construction perimeter, on floors of new buildings and at off–site storage areas. Small cranes and trucks will handle materials at deck level and a large climbing tower crane will be used for the office building.

Emergency Egress

Emergency egress will be provided from 101 Huntington Avenue, Saks Fifth Avenue, and the Copley Place bridge by existing exits into walkways through the construction site, or approved alternate egress routes will be developed. Fire department access to the Phase 2 area will remain unchanged from South Ring Road, Huntington Avenue, and East Ring Road.

Traffic Rerouting

Demolition work and the foundations for the new office building will extend to the property boundary along Huntington Avenue. Consequently, the edge of the construction site will need to extend beyond the boundary of the Prudential Center, at least to the northern curb of Huntington Avenue to provide room to build the foundation. A traffic lane along the northern side of Huntington Avenue may need to be reduced in width. The Construction Management Plan will completely discuss any necessary traffic rerouting for this phase of the redevelopment project.

Phase 3 – Neighborhood Commercial Center/Child Care Center

Perimeter Protection

Construction fencing and partitions will surround the perimeter as in other phases.

Pedestrian Access

Temporary partitions and signs will be used inside the Gloucester apartment building to direct pedestrians around the construction. During portions of Phase 3 construction, sidewalks immediately adjacent to the construction perimeter along Huntington Avenue, East Ring Road, and Exeter Street will be closed to protect pedestrians. Pedestrians will either be directed across the streets or into enclosed walkways along the perimeter of the construction site. Within the site, walkways will be maintained between the Gloucester apartment building, Exeter Street, and East Ring Road. A walkway will be maintained through the northern end of the construction site between East Ring Road and Exeter Street. The location of this walkway will shift as construction progresses.

Construction Material Handling

Construction loading docks will be located at Exeter Street and East Ring Road. Small trucks and cranes will handle the construction material within the site perimeter at the deck level. Construction materials will be stored at deck level within the site perimeter and at off-site storage areas.

Emergency Egress

Emergency egress will be provided from the Gloucester apartment building through the walkways maintained within the site perimeter, or approved alternate egress routes will be developed. Fire department access to the Phase 3 construction site will remain unchanged from East Ring Road, Exeter Street, and Huntington Avenue.

Traffic Rerouting

No major traffic rerouting is anticipated for Phase 3. The Construction Management Plan will completely discuss any necessary traffic rerouting for this phase of the redevelopment project.

Phase 4 – Belvidere Office Building

Perimeter Protection

Fencing and partitions will enclose the Phase 4 construction area. Along Huntington Avenue and Belvidere Street, the fencing will stay as close to the foundation wall as possible while still permitting construction work.

Pedestrian Access

During portions of the Phase 4 construction period, sidewalks along the north side of Huntington Avenue and east side of Belvidere Street will require closing to protect pedestrians. Pedestrians may be diverted to the south side of Huntington Avenue and the west side of Belvidere Street. There are no existing buildings that will be operating within the boundaries of Phase 4. Therefore, pedestrian access within the site will be limited. Pedestrians approaching Phase 4 from the north will be diverted to the west

through the completed Phase 1 area, or east through the Phase 2 area. The south side of the Sheraton Hotel may require egress to Belvidere Street. In addition, appropriate measures will be taken to maintain access to the Prudential Center Green Line MBTA stop.

Construction Material Handling

Trucks will deliver construction materials to loading areas on Huntington Avenue and Belvidere Street. Small cranes and trucks will handle materials at the deck level and a large crane will be used for the office building. Materials will be stored at the deck level within the site perimeter, on the floors of the new buildings and at off–site areas.

Emergency Egress

Only a minimal amount of emergency egress through the construction site is expected from the surrounding buildings. What is required will come from the existing exits into walkways through the construction site or approved alternate egresses will be developed. Fire department access to the Phase 4 construction site will remain unchanged over the plaza from Huntington Avenue and Belvidere Street as it is today.

Traffic Rerouting

The edge of the construction site will extend a few feet beyond the boundary of the Prudential Center at least to the northern curb of Huntington Avenue to provide adequate room for construction on the foundation wall. On Belvidere Street, the edge of the construction site will extend into the street for foundation work. The Construction Management Plan will completely discuss any necessary traffic rerouting for this phase of the redevelopment project.

Phase 5 – West Boylston Street Residences

Perimeter Protection

As in other phases, the site will be isolated by fencing and temporary partitions.

Pedestrian Access

During portions of the Phase 5 construction period, sidewalks along the south side of Boylston Street will need to be closed to protect pedestrians. Pedestrians may be diverted to the north side of Boylston Street. Little or no pedestrian flow is anticipated through the Phase 5 construction site. Pedestrian traffic will be diverted around the site.

Construction Material Handling

A construction loading dock will be located within the construction perimeter in the parking lane of Boylston Street. A crane will transfer material to the deck level and will service the new building. Smaller cranes and trucks will handle materials at the deck level. Materials will be stored at the deck level within the construction perimeter, on the floors of the new buildings, and at off-site areas.

Emergency Egress

Emergency egress will be provided from the Fairfield apartment building using the existing exits into walkways through the construction site, or approved alternate egresses will be developed. Fire department access to the Phase 5 construction site will remain unchanged from Boylston Street.

Traffic Rerouting

No major traffic rerouting is anticipated. North Ring Road will be closed at this time. The parking lane on the south side of Boylston Street will be included in the site perimeter. The Construction Management Plan will completely discuss any necessary traffic rerouting for this phase of the redevelopment project.

Phase 6 - Boylston Street Office

The staging measures for this phase will be similar to Phase 5. The construction loading dock may be located more in the North Ring Road area and less in the Boylston Street parking lane since the building will set back from the street. The same measure

will be carried out for pedestrian access in and around the site and the handling of construction materials will be accomplished in the same manner. No major traffic rerouting is anticipated The Construction Management Plan will completely discuss any necessary rerouting for the redevelopment project.

Phase 7 – East Boylston Residences

Perimeter Protection

The construction area will be isolated using fencing and temporary partitions.

Pedestrian Access

As in Phases 5 and 6, pedestrians will be diverted to the north side of Boylston Street. Pedestrians will be diverted to the east side of East Ring Road. Construction is anticipated to be completed in Phase 3 so the sidewalk on the east side of the road will be open. Pedestrian access to the apartment buildings within the construction site will be provided through enclosed walkways.

Construction Material Handling

The primary construction loading dock will be located within the construction perimeter in the parking lane on the south side of Boylston Street. A large crane will be placed at the loading dock to transfer material to and from the higher deck elevation and service the new building. Smaller cranes and trucks will handle material at the plaza level. Construction material will be stored at the deck level within the construction perimeter, on the floors of the new buildings, and off-site areas.

Emergency Egress

Emergency egress from the existing apartment buildings will be provided using the existing exits into walkways through the construction site or approved alternate egresses will be developed. Fire department access for the Phase 7 construction area will remain unchanged from Boylston Street.

Traffic Rerouting

No major traffic rerouting is anticipated. The parking lane on the south side of Boylston Street will be included in the construction perimeter. The Construction Management Plan will fully discuss any traffic impacts from this phase of the redevelopment project.

6.4 Air Quality

6.4.1 Potential Impacts

Air quality impacts resulting from construction are expected to be minor. The primary potential for impacts is dust generated during the demolition stage. Pollution generated from construction-related traffic and construction machinery should be minor and not result in any impact to air quality.

Demolition will include the removal of 142,800 gross square feet of existing retail space, on and below-grade portions of the North and South Ring Roads, and small sections of three-story parking deck both north and south of the Prudential Tower. Since the areas to be demolished are low-lying or subsurface deck areas, airborne dust generation should be minimal. There will be no major excavation activities, which can be the largest source of dust generation in most construction projects. The phasing of the construction will reduce peak volumes of demolition debris and associated dust generation.

6.4.2 Mitigation Measures

Standard mitigation practices will be employed to further reduce dust generation.

On-site measures will include:

- Wetting of debris.
- Minimizing storage of debris on-site.
- Monitoring of construction practices to ensure that unnecessary transfers and mechanical disturbances of loose materials are minimized.

- o Periodic street and sidewalk cleaning to minimize dust accumulations.

Off-site measures will include:

- o Covering the truck trailers which haul debris from the construction site.

- o Periodic street and sidewalk cleaning in areas where dust accumulations are heavy.

6.5 Truck Routes and Volumes

Several issues were taken into consideration in determining the possible truck routes to and from the Prudential Center. The size and duration of the Prudential Center Redevelopment make it difficult to determine the sources of all the construction materials, or the destinations of all the demolition debris. As a result, designated truck routes and truck volumes from each likely direction are discussed. A more detailed discussion of construction traffic volumes is included in the Prudential Center Redevelopment Transportation Access Plan (DPIR/EIR, Volume III).

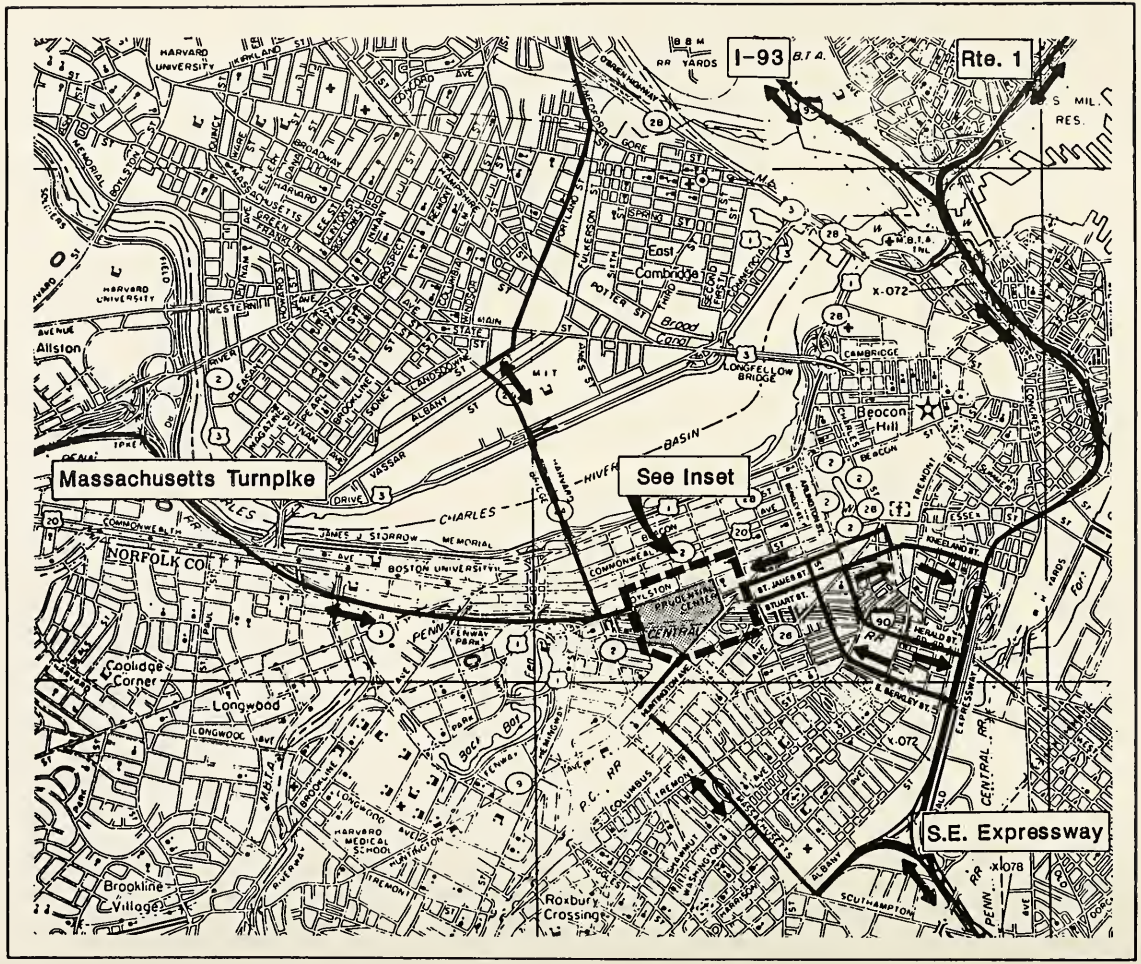
Limiting the impacts of construction traffic and truck noise on the adjacent neighborhoods were the most important factors in determining these routes. These goals are best achieved by designating approach and departure routes from each likely direction (north, south, and west) that utilize major thoroughfares through the City whenever possible. Figures IV-29A and IV-29B indicate the preferred routes to and from the north, south, and west. Enforcement of these designated routes will be accomplished through clauses in the contractor and subcontractor's agreements.

Northern Routes

Inbound:

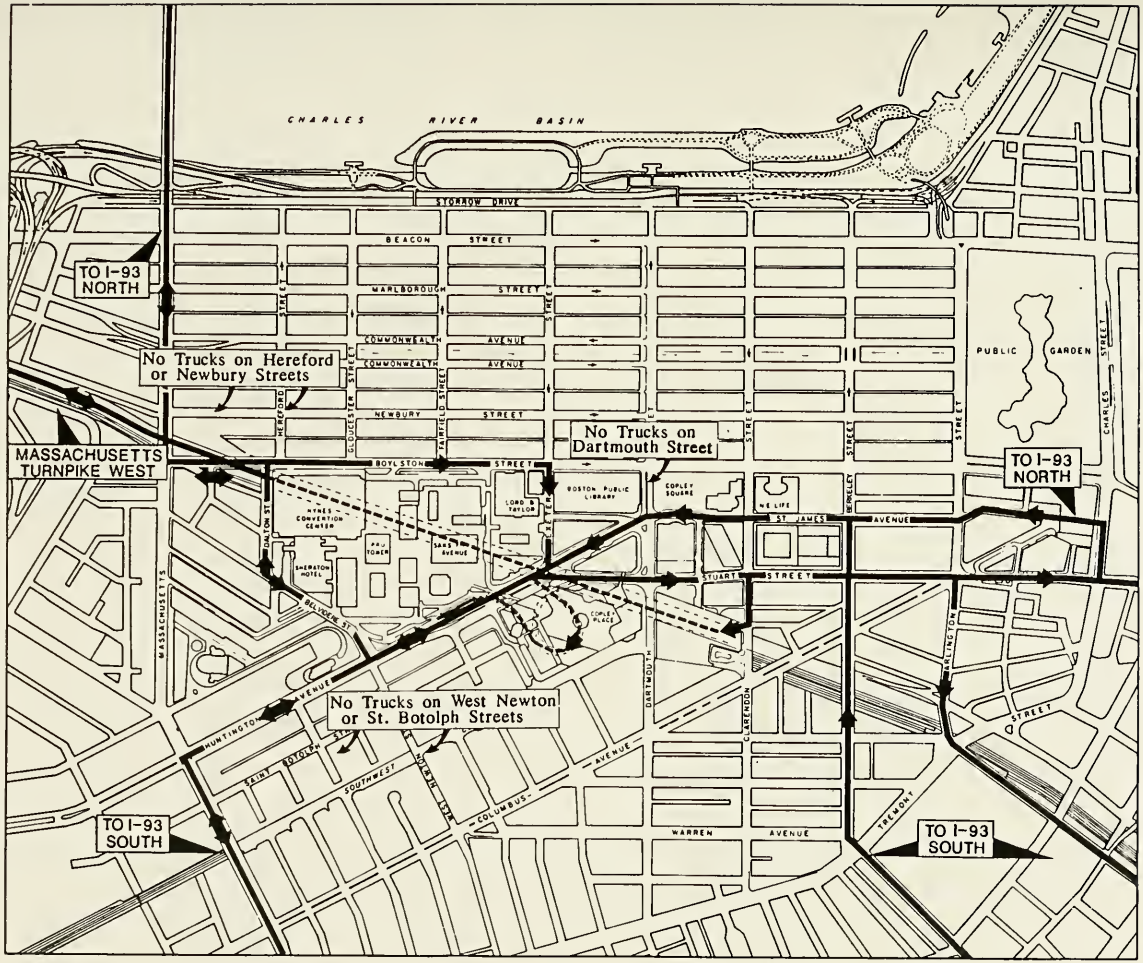
i) I-93 to O'Brien Highway to Portland Street to Massachusetts Avenue to Boylston Street

ii) I-93 to Kneeland Street to Charles Street to St. James Avenue to Huntington Avenue



Prudential Center Redevelopment

Fig. IV-29A
Designated Truck Routes



Prudential Center Redevelopment

Fig. IV-29B
Designated Truck Routes

0 200 400
Scale feet

Outbound:

i) Belvidere Street to Dalton Street to Boylston Street to Massachusetts Avenue to Portland Street to O'Brien Highway to I–93

ii) Huntington Avenue to Stuart Street to Kneeland Street to I–93

Southern Routes

Inbound:

i) I–93 to Massachusetts Avenue to Huntington Avenue

ii) I–93 to Frontage Road to Berkeley Street to St. James Street to Huntington Avenue

Outbound:

i) Huntington Avenue to Massachusetts Avenue to I–93

ii) Huntington Avenue to Stuart Street to Arlington Street to Herald Street to Albany Street to I–93

Western Routes

Inbound:

i) Massachusetts Turnpike to Huntington Avenue off–ramp

Outbound:

i) Huntington Avenue to Stuart Street to Clarendon Street on–ramp

ii) Boylston Street to Exeter Street to Stuart Street to Clarendon Street on–ramp

The volume of trucks on each route will depend on the origin or destination of construction materials. Adjacent to the Prudential Center, the volume of the construction traffic on Huntington Avenue will most likely be greater than the volume on Boylston Street in Stage I. In Stage II, the volume will most likely shift to Boylston Street. The same designated routes will be used for any of the proposed alternatives. The scaled down alternatives (B, B2, C, and C2) will result in less traffic volumes than Alternative A or A2.

6.6 Foundation Construction

Foundation construction will be limited to the office and residential towers. The existing foundation system and structural elements on the Prudential Center site make heavy redevelopment in certain areas of the site less disruptive than others. Most of the deep foundation buildings will be constructed near the Prudential Center perimeter to minimize demolition of multi-level garage areas. All of the office and residential buildings will be built on areas that presently have foundations bearing above the clay stratum. The new office and residential towers will each employ deep foundation systems bearing below the clay stratum. Figure IV-30 shows the existing configuration of foundation types at the Prudential Center.

The footprints of buildings requiring foundation work will be approximately the same for each of the alternatives, therefore, the following discussion applies to all alternatives.

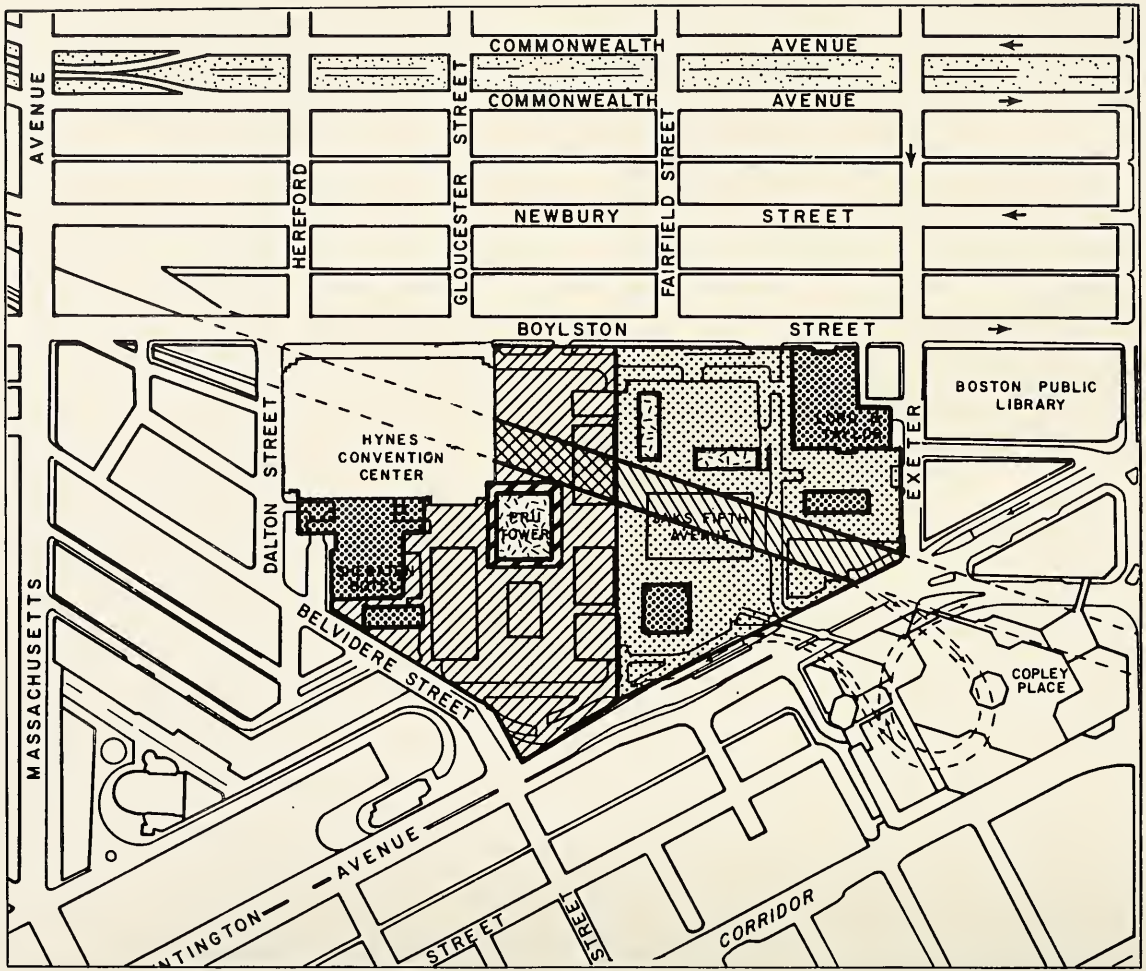
6.6.1 Foundation Construction Methodology

Holes will be cut in the concrete mats for the new piles and caps. Localized dewatering will be carried out at these pile caps if necessary. Piles will be wet-rotary pre-drilled through the clay stratum to limit the amount of pile driving and reduce disturbance of the clay. The Prudential Center's existing settlement monitoring program will be extended to include off-site structures. If movements are detected, construction techniques will be modified to prevent adverse impacts.

6.6.2 Impacts on Adjacent Buildings

Vibration is an important concern in terms of impacts on adjacent structures during foundation work. In addition to existing conditions which help isolate these buildings from surrounding structures, steps will be taken to limit these vibrations and effectively mitigate impacts.

The existence of separate settlement joints for each Prudential Center building will help buildings absorb vibrations without damage. All of the existing buildings remaining upon completion of the redevelopment project, with the exception of Saks 5th Avenue, have deep foundations which will provide separate support to help secure these buildings from construction vibrations.



Prudential Center Redevelopment

Fig. IV-30 Existing Foundation Types

Deep Foundations

- 16" Pipe Piles to Till
- Steel H Piles to Till
- Caissons to Bedrock

Shallow Foundations

- Frankl Piles Driven to Outwash Sand
- Cobi Piles Driven to Outwash Sand
- Concrete Mat on Layer of Outwash Sand Above Clay
- Short Wooden Piles Driven to Outwash Sand

0 200 400
Scale : feet

For the foundation stage of construction, vibrations and clay disturbance will be greatly reduced by pre-drilling the end bearing piles for the office and residential buildings. The phasing of the construction will limit the intensity of vibrations by limiting the overlap of foundation work for the office towers on Huntington Avenue and foundation work for the residential buildings on Boylston Street.

Settlements associated with pile installation may initially affect the existing shallow foundations which support other Prudential property immediately adjacent to the proposed construction. For almost 30 years, the Prudential Property Company, Inc. has systematically executed an on-site settlement monitoring program, recording the impacts of nearby construction on the settlement of existing shallow foundations at the Prudential Center. As mentioned above, this settlement monitoring program will now be extended to include off-site structures. Adjacent properties will be systematically monitored during construction to detect any movements. Should movements be detected, construction techniques will be modified to mitigate adverse activities.

6.6.3 Impacts on Utility Lines

No impacts on the service of various utilities due to foundation work for the proposed construction at the Prudential Center are expected. The developer will reroute utilities, as necessary, to prevent any interruption in sewer, water, or power service. Close coordination with Boston Edison will insure that Boston Edison's System Control and Data Acquisitions Center will not be impacted by the construction activities. Utility operations requiring trenching in public ways will be done at night with trenches covered with steel plates to maintain traffic during daytime hours. Site work improvements will be staged to maintain pedestrian and vehicular traffic in a safe manner. All traffic staging proposals will be approved by the Boston Transportation Department before implementation.

6.6.4 Impacts on Transportation Easements

The redevelopment plan for the Prudential Center has been designed to limit the impacts on the transportation easements that cross the site. Construction work in Phase 3 will occur over the Turnpike and rail easements. Only support structure work will occur on the existing deck during this phase. Foundation work will occur adjacent to the

Turnpike for the office building on Boylston Street during Phase 6. The retaining wall of the Turnpike will not be breached in either phase. No restrictions on traffic flow are expected. This issue will be fully addressed in the Construction Management Plan.

6.6.5 Impacts on Groundwater

The proposed redevelopment project requires no foundation excavation. This minimizes impacts on groundwater levels. The only construction expected to occur below the existing water level is pile emplacement and capping for the office and residential towers. Some limited dewatering may be necessary in order to construct pile caps. Care will be taken during construction to ensure that this limited dewatering does not impact groundwater levels within or outside the Prudential Center.

The Prudential Center is essentially surrounded by a steel sheet pile cofferdam constructed when the project was originally built in the late 1950's. This cofferdam has the effect of isolating the water levels within the project from those water levels outside the Prudential Center, to a large degree. Additionally, water levels within the Prudential Center are monitored with a system of groundwater observation wells installed through the floor slab of the lowest parking level.

Localized dewatering for pile cap construction should have a short-term impact only on water levels in the immediate vicinity of the pile cap being constructed. Any impact will be isolated, to a large degree, to the Prudential Center by the sheet pile cofferdam and will be monitored by on-site monitoring wells. The Prudential Center's existing comprehensive program of on-site groundwater monitoring wells will be extended to include more observation wells prior to the start of construction activities. These wells will be monitored to detect any impact on water levels. If changes are detected, immediate counter-measures will be taken.

6.7 Public Safety

As a public safety provision during the proposed construction at the Prudential Center, police officer traffic control will be used as necessary through all phases of construction. The need for police officers will be determined jointly with the Boston Transportation Department and provided as required. Detail officers on assignment in the

construction zone will be responsible for maintaining a safe and orderly flow of vehicles and pedestrians as well as responding to any unforseen events. The presence of an officer will be an added safety measure since a private security detail already patrols the Prudential Center 24 hours a day.

Access to the construction areas will be limited by perimeter controls, such as temporary construction fencing. Appropriate signage will be provided along with the enclosed plywood walkways to promote positive pedestrian routing around and through the Prudential Center.

The developer recognizes the potential impacts of construction on pedestrian circulation patterns through and around the site. To deal with this issue, the developer is prepared to design appropriate signage to direct pedestrians through or around the construction areas. An important goal of the project is to keep the Sheraton Hotel, the Hynes Convention Center, the residential buildings, the retail areas, and the existing office buildings all functioning with as little disruption as possible.

Any additional safety measures needed will be addressed in the Construction Management Plan to be completed prior to the start-up of the construction activities.

7.0 HISTORIC RESOURCES

7.1 Existing Conditions

The Prudential Center is located in an historically important area of Boston. According to the Massachusetts Historical Commission records, there are no archaeological resources in the vicinity of the Prudential Center. However, there are historic districts and individual buildings included on the National Register of Historic Places. In addition, the Boston Landmark Commission has studied buildings and districts near the Prudential Center and recommended that additional historic designations be made. Figure IV-31 shows the boundaries of the districts, the location of National Register properties, and the Boston Landmark Commission recommendations in the project study area.

Districts Meeting Criteria for National Register and Landmark Designation

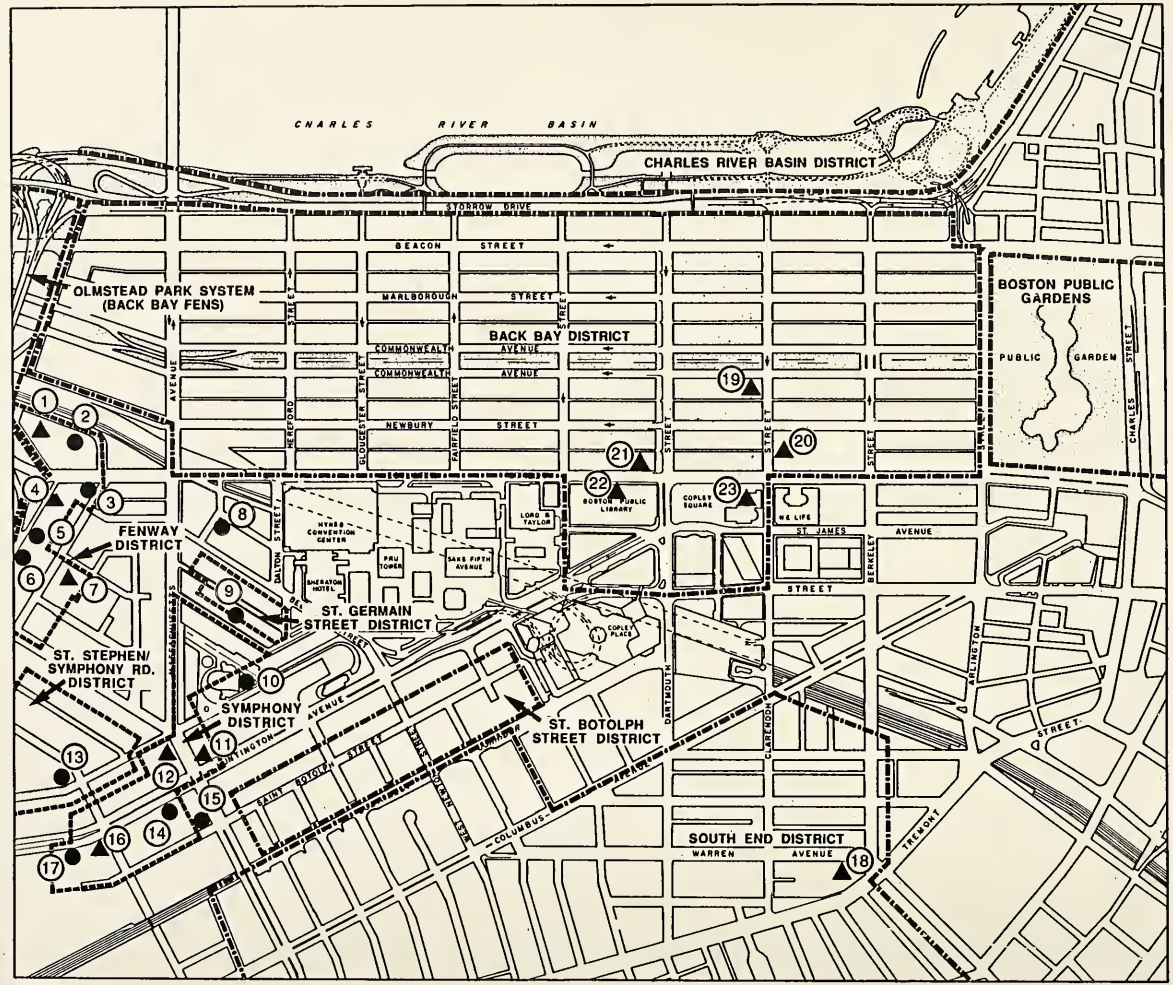
Symphony District – The district is considered eligible for its concentration along Massachusetts and Huntington Avenues of prominently sited architecturally distinguished buildings which serve as the homes of cultural, educational, and religious institutions of major importance to the City of Boston and the nation. They remain as an intact grouping of important works by architects of local, regional and national influence. Included in the district are three National Register properties – Symphony Hall, Horticultural Hall and the New England Conservatory of Music.

Charles River Basin District – Established in the 19th century, the district includes the Charles River Basin and both banks from the Charles River Dam to the Eliot Bridge. The construction of the dam in 1910 converted these once tidal mud flats into a recreational area that is a focal point of Boston's park system today. Included in the district is the historic Longfellow Bridge, originally known as the Cambridge Bridge.

Fenway District – This area is considered eligible for its impressive group of residential and institutional buildings, many of which are of local, regional and national significance. The buildings date from the early 1890's through the 1920's.

Prudential Center Redevelopment

Fig. IV-31 Historic Resources In The Vicinty Of The Site



1. Fenway Studios
2. St. Clements Roman Catholic Church
3. Berkely College of Music
4. Massachusetts Historical Society
5. Boston Conservatory of Music
6. Morfield and Gertrude Story House
7. New Riding Club
8. St. Cecilia Roman Catholic Church
9. Christian Science Publishing Society
10. First Church of Christ Science
11. Horticultural Hall
12. Symphony Hall
13. St Ann's Roman Catholic Church
14. Boston University Theater
15. The Cotting School for Handicapped Children
16. New England Conservatory of Music
17. YMCA
18. Cyclorama Building
19. First Baptist Church
20. Trinity Rectory
21. Old South Church
22. Boston Public Library
23. Trinity Church

---EXISTING DISTRICTS

---ELIGIBLE DISTRICTS

● RECOMMENDED BY BOSTON LANDMARK COMMISSION FOR HISTORIC DESIGNATION

▲ NATIONAL REGISTER PROPERTIES

0 200 400
Scale : feet

They represent the full range of architectural styles of that era. Fenway Studios and the Massachusetts Historical Society are two National Register properties in the district.

Districts Meeting Criteria for National Register and Architectural Conservation District Designation

Back Bay District – This district was listed on the National Register in 1973. It is presently a densely built up area of fashionable apartments, office and business facilities, schools and other institutions. While pure examples of many architectural styles exist, variations combining elements from two or more styles are common. Most of its original structures survive, and despite many variations in architectural style, they are distinguished by a general consistency of character, form and scale. Copley Square remains the most important public space in the district. The Public Library (McKim, Mead, and White, 1887), Trinity Church (H. H. Richardson, 1877), Old South Church (Cummings and Sears, 1875), and the Copley Plaza Hotel (Henry Hardenburgh, 1912) define the square and characterize its public importance.

St. Germain Street District – The buildings on this street are considered eligible as an intact pocket of modestly scaled 1890's Queen Anne and Romanesque Revival single and three-family row housing which has retained much of its original architectural character, style and detail. St. Germain Street is of particular importance as the last remaining grouping of red brick residences and multiple-unit housing that developed during the 1880's and 1890's in the vicinity of Massachusetts Avenue, Falmouth, Norway and Dalton streets, which was characteristic of that area prior to the development in the 1970's of the Christian Science Center.

St. Stephen/Symphony Road District – This East Fens area is considered eligible as a protected district for its inclusion of architecturally significant and substantially intact single-family rows dating from the mid-1880's through the early 1890's and multiple-unit 4 and 5-story residential buildings of high design quality dating from the late 1880's through the 1910's. Included in this district is St. Ann's Roman Catholic Church, which has been recommended for the National Register by the Boston Landmarks Commission.

St. Botolph District – The St. Botolph Architectural Conservation District is a small, visually and geographically cohesive, twelve-block area of predominantly red brick residential row houses built during a two-decade period from 1881-1902. Although it is part of the large scale reclamation project of Boston tidal flats that took place during the 19th century, the St. Botolph area has a different character than the rest of the Back Bay. The two major arteries of Huntington and Massachusetts Avenues and the Copley Place site increase its self-containment. Architectural styles are generally mixed, without loss of integrity, which reflects different architects and periods of construction creating interest and charm.

South End District – The South End is a large but well-defined densely built-up area which is characterized by architecture of relatively few building types. It presents a unified environment distinguished by subtle variations in architectural style, detailing, building height, and street width and direction, and by the presence or absence of park areas. Planned in 1848 and developed in part on filled land through the early 1870's, the South End of Boston is the largest remaining Victorian urban residential neighborhood in the United States.

7.2 Potential Impacts

The Prudential Center is located adjacent to the Back Bay Historic District. Its southwestern corner is also adjacent to the St. Germain Street District which is eligible for inclusion as a National Register historic district.

The new Prudential buildings are being designed so that the surrounding historic resources will not be adversely impacted. No tall structures will be constructed along Boylston Street adjacent to the Back Bay. The south side of the site abuts an area which includes a combination of both old and new. The taller buildings proposed for this project will be located on this portion of the site, along Huntington Avenue, and will not be immediately adjacent to any historic resources in the area.

A prominent feature of the Back Bay and South End districts is the grid structure dividing the districts into a series of blocks and streets. At present, the Prudential Center is a departure from this form. By breaking the Prudential Center into a series of blocks bordered by pedestrian ways, and by building out to the street lines on Boylston Street and Huntington Avenue, the Center should become a more integral part of the City fabric.

8.0 RODENT CONTROL

The City of Boston has declared that the infestation of rodents in the City is a serious problem. In order to control this infestation, the City has established requirements under the Massachusetts State Sanitary Code, Chapter II, 105 CMR 410.550 and the State Building Code, Section 108.6. Policy Number 87–4 establishes that extermination of rodents shall be required for issuance of permits for demolition, excavation, foundation, and basement rehabilitation.

Presently, the Prudential Center has an active Pest Control Program. The program provides for progressive treatment 3–4 times per week to all interior and exterior common areas of the Prudential Tower, 101 Huntington Avenue Building, the garage and apartments. It includes the monitoring of potential sanitation and structural problems which could be eliminated or controlled to curb the pest situation at the Center. Licensed and certified pest control operators carry out this existing program.

The Prudential Center management contractor doubled its 1989 Pest Control Budget over 1988 funding in anticipation of the proposed redevelopment program. The rodent control program will again be updated and expanded to accommodate the added impacts from construction at the Prudential Center with the help of a licensed exterminator prior to beginning any work on the project.

A rodent extermination certificate will be filed with the building permit application to the City. Rodent inspection, monitoring, and treatment will be carried out before, during, and at the completion of all foundation work for the proposed project, in compliance with the City's requirements. Rodent extermination prior to work start–up will consist of treatment of areas throughout the project area, including alleyways, surrounding building exteriors, and building interiors. During the construction process, regular service visits will be made in order to maintain effective rodent control levels.

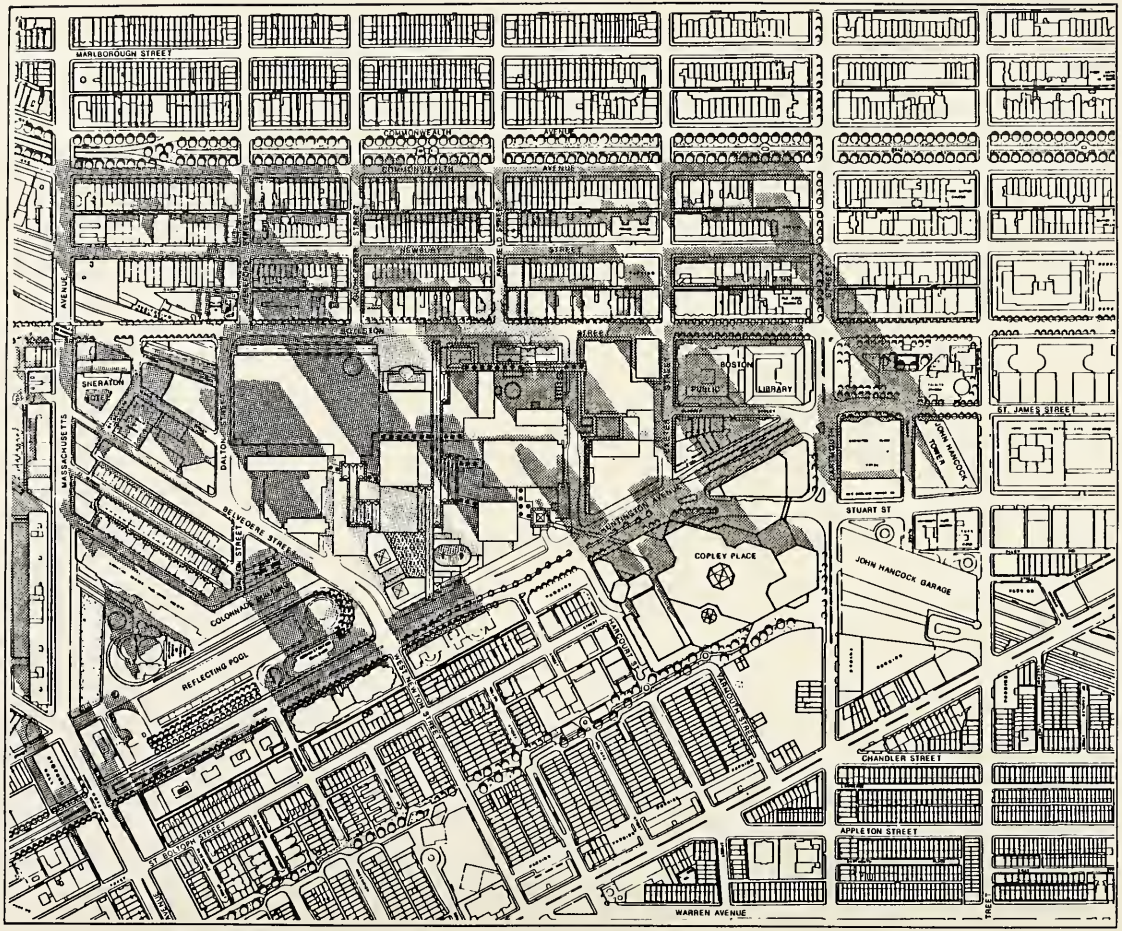
APPENDIX A

Horizontal shadow profiles compiled for each alternative are shown in Figures IVA-1 through IVA-52. The diagrams show existing shadows indicated by a dark dot pattern. Additional shadows associated with introduction of the project's new buildings are indicated by a light dot pattern. The net new shadow is the measure of the project's shadow impact on the areas in which new shadows fall on previously sunny places.

This appendix presents the results of the shadow studies conducted for the Prudential Center Redevelopment project. Horizontal shadow profiles were compiled to depict the extent of additional shadows associated with the new buildings of each of the alternatives.

Shadows for each season were studied as follows for Alternatives A and A2: summer solstice (June 22); vernal equinox (March 21); autumnal equinox (September 23); and winter solstice shadow (December 22). For each of these times of year, representative morning (9:00 AM), noon (12:00 PM), and afternoon (3:00 PM) shadow patterns were calculated and plotted. Additional shadow analyses were also conducted for 10:00 AM, 11:00 AM, 12:00 Noon, 1:00 PM, and 2:00 PM on October 21 and November 21 to define sunlight conditions in the later fall (and early spring) when sunlight can extend the use of outdoor spaces. For Alternatives B, B2, C, and C2, shadow studies were compiled for the vernal equinox (March 21) and autumnal equinox (September 23) at 2:00 PM.

An analysis of the impacts depicted in these shadow studies on sensitive areas is included in Section 1.0 of this report.



Prudential Center Redevelopment

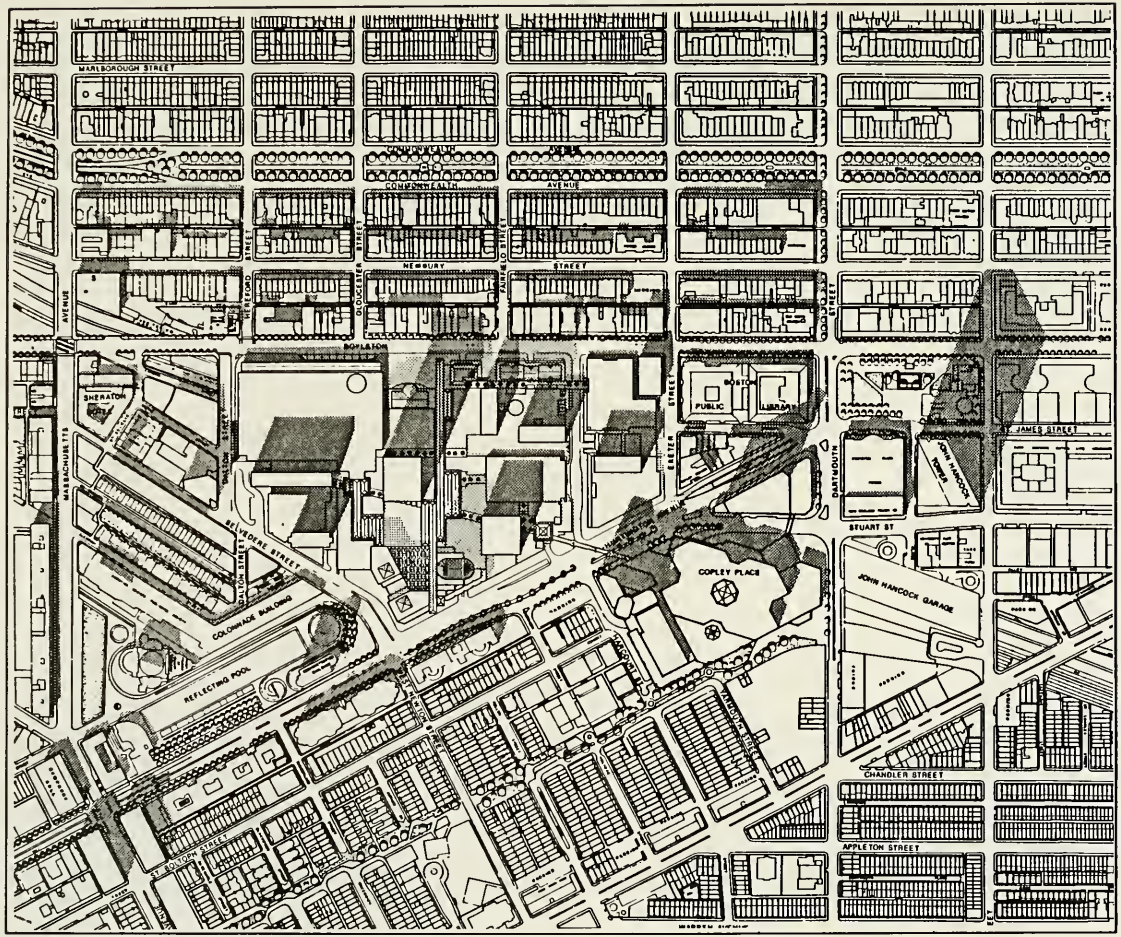
Fig. IVB-1
Horizontal Shadow Profile

Alternative A
March 21
9:00 AM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



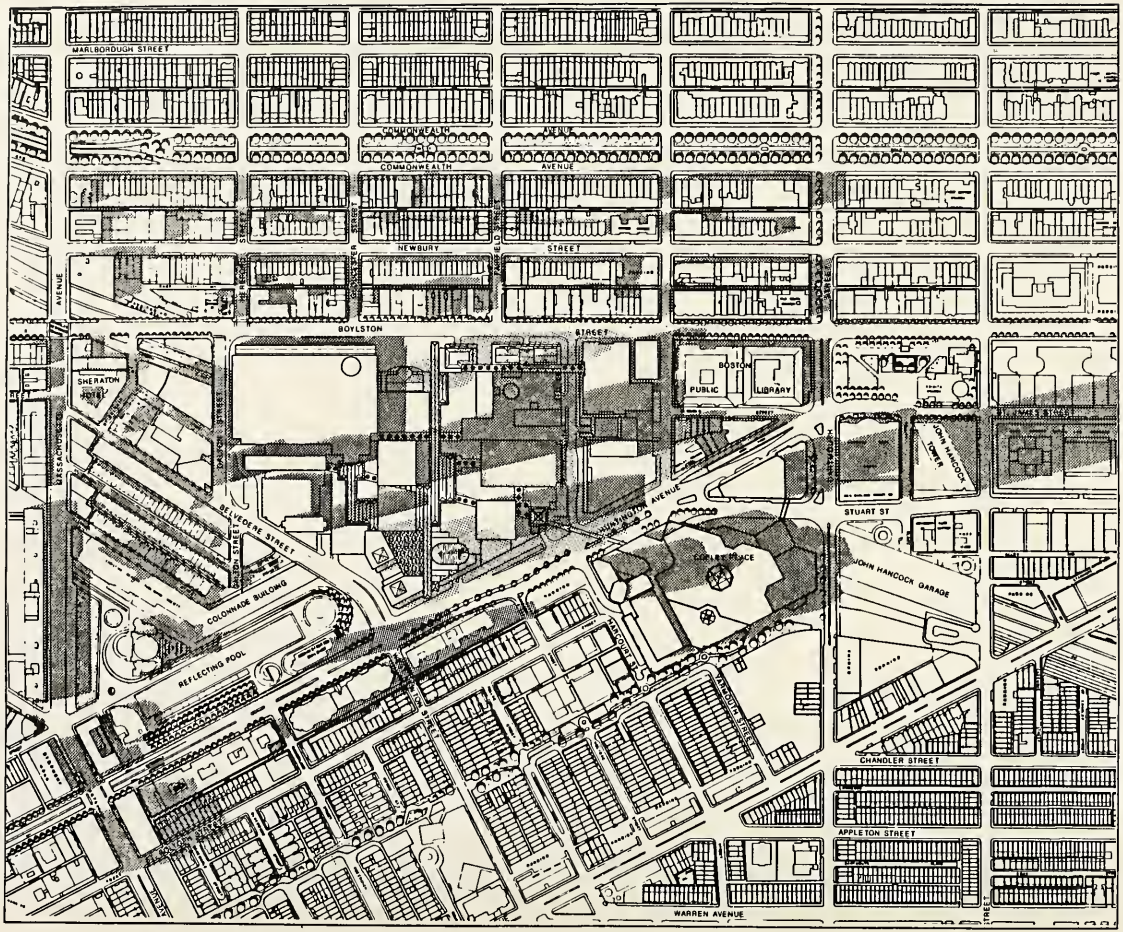
Prudential Center Redevelopment

Fig. IVB-2
Horizontal Shadow Profile

Alternative A
March 21
12:00 PM EST

EXISTING SHADOW

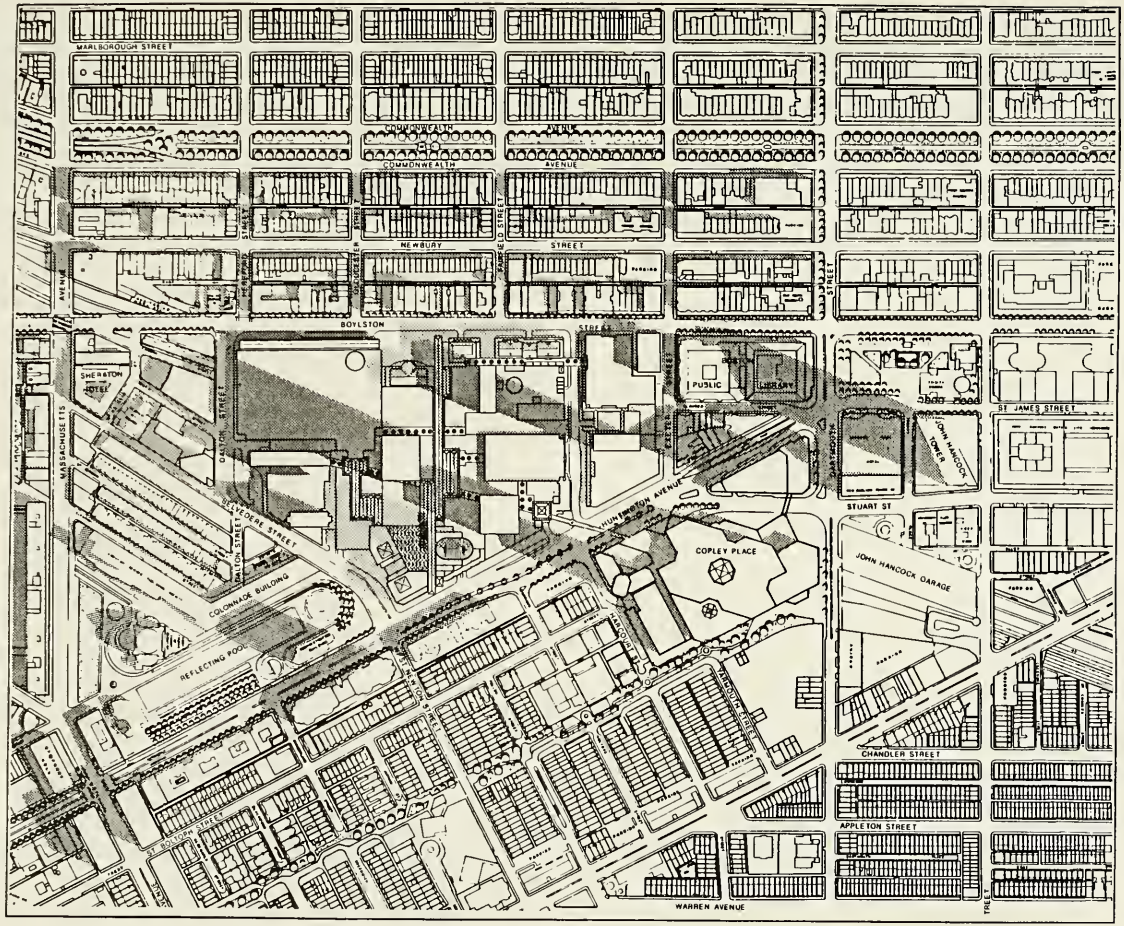
NET NEW SHADOW



Prudential Center Redevelopment

Fig. IVB-3
Horizontal Shadow Profile

Alternative A
March 21
3:00 PM EST



Prudential Center Redevelopment

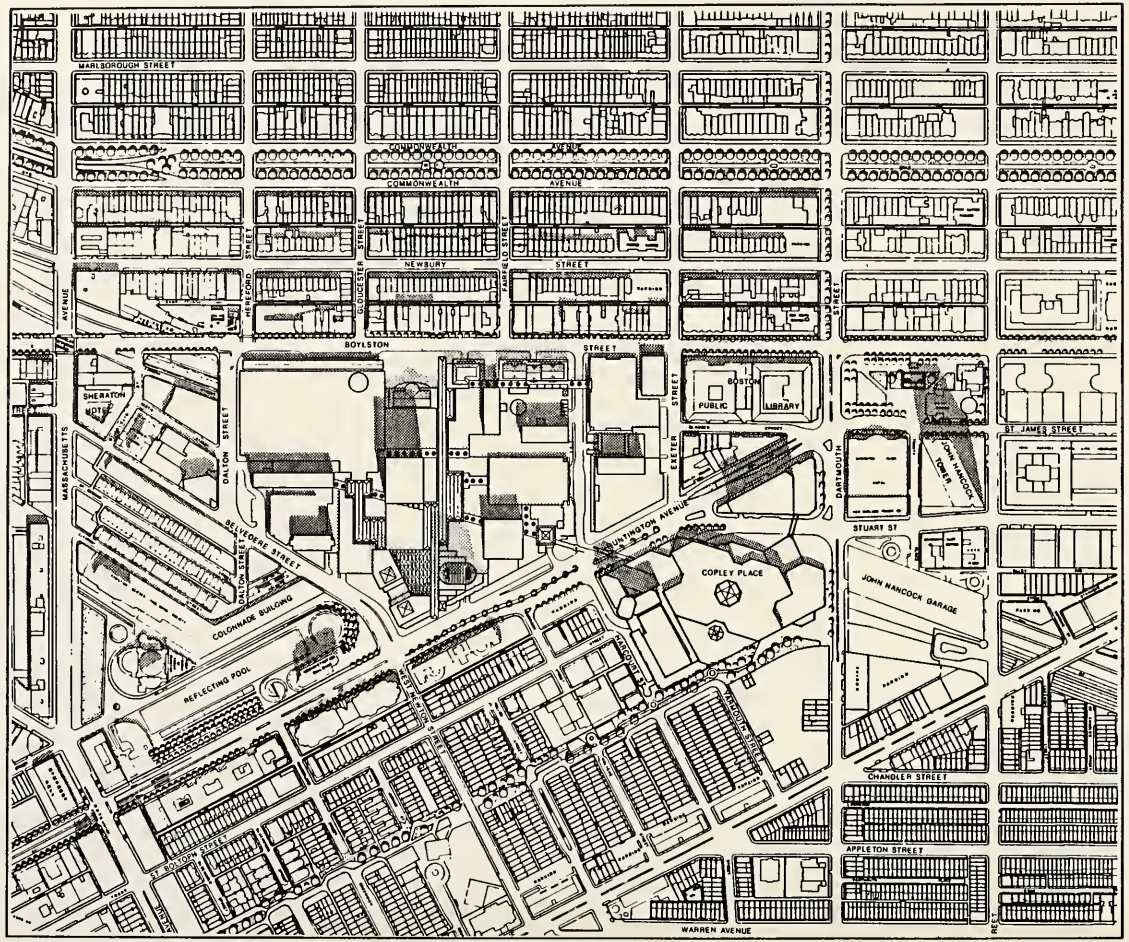
Fig. IVB-4
Horizontal Shadow Profile

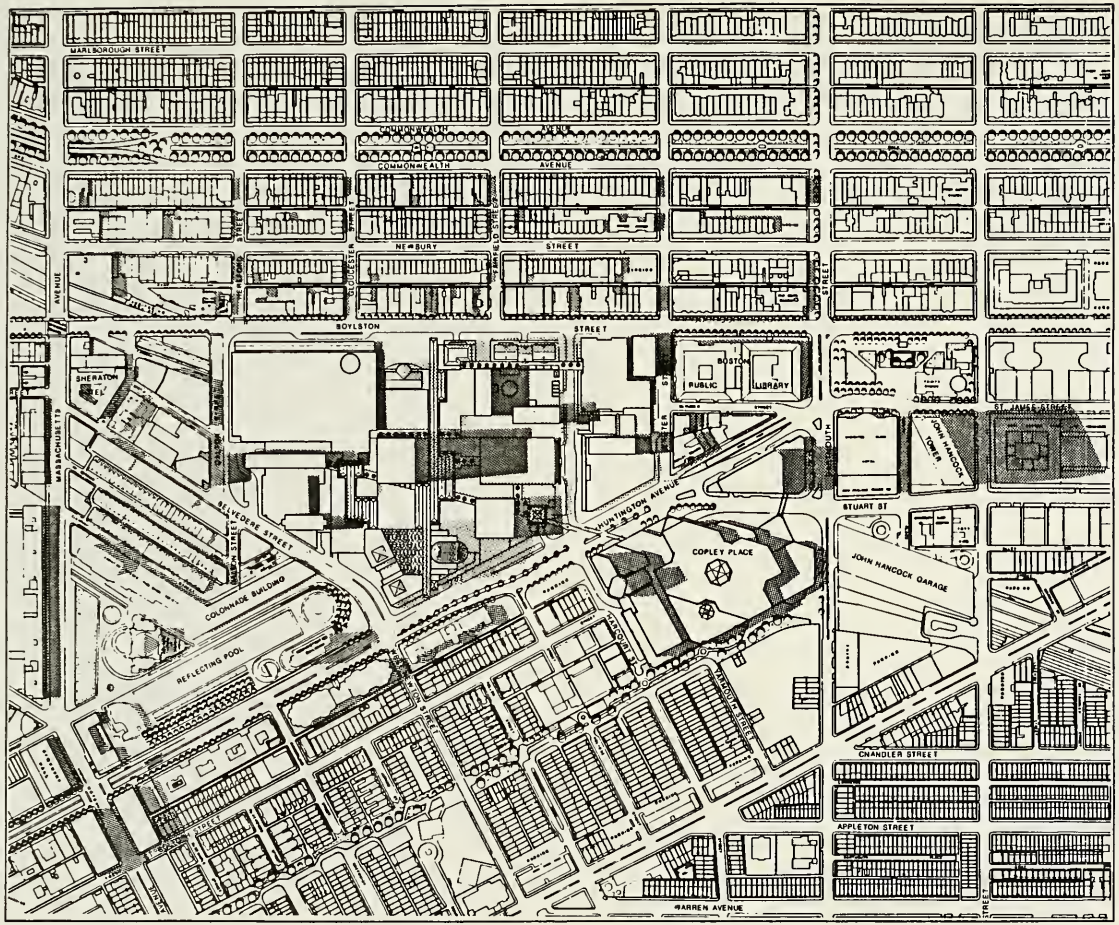
Alternative A
June 22
9:00 AM EDT

Prudential Center Redevelopment

Fig. IVB-5
Horizontal Shadow Profile

Alternative A
June 22
12:00 PM EDT





Prudential Center Redevelopment

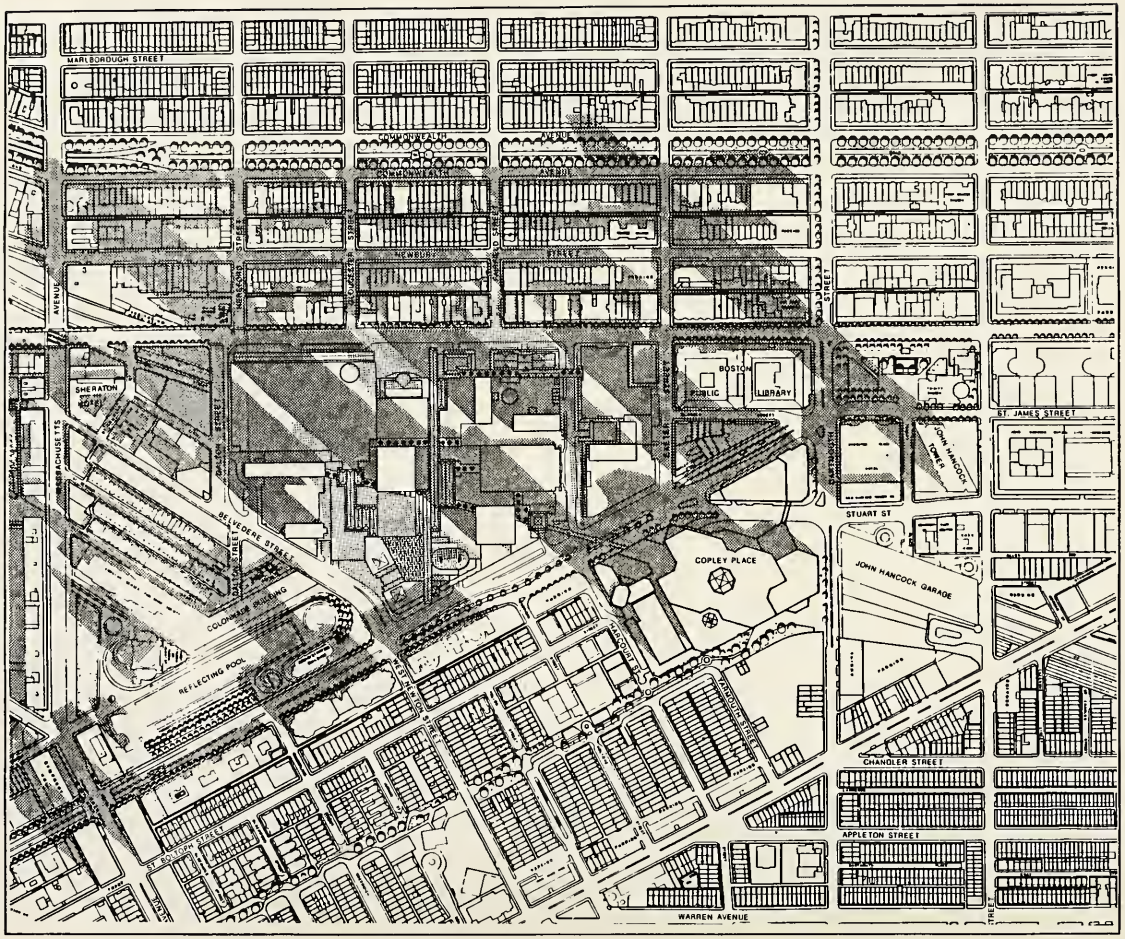
Fig. IVB-6
Horizontal Shadow Profile

Alternative A
June 22
3:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

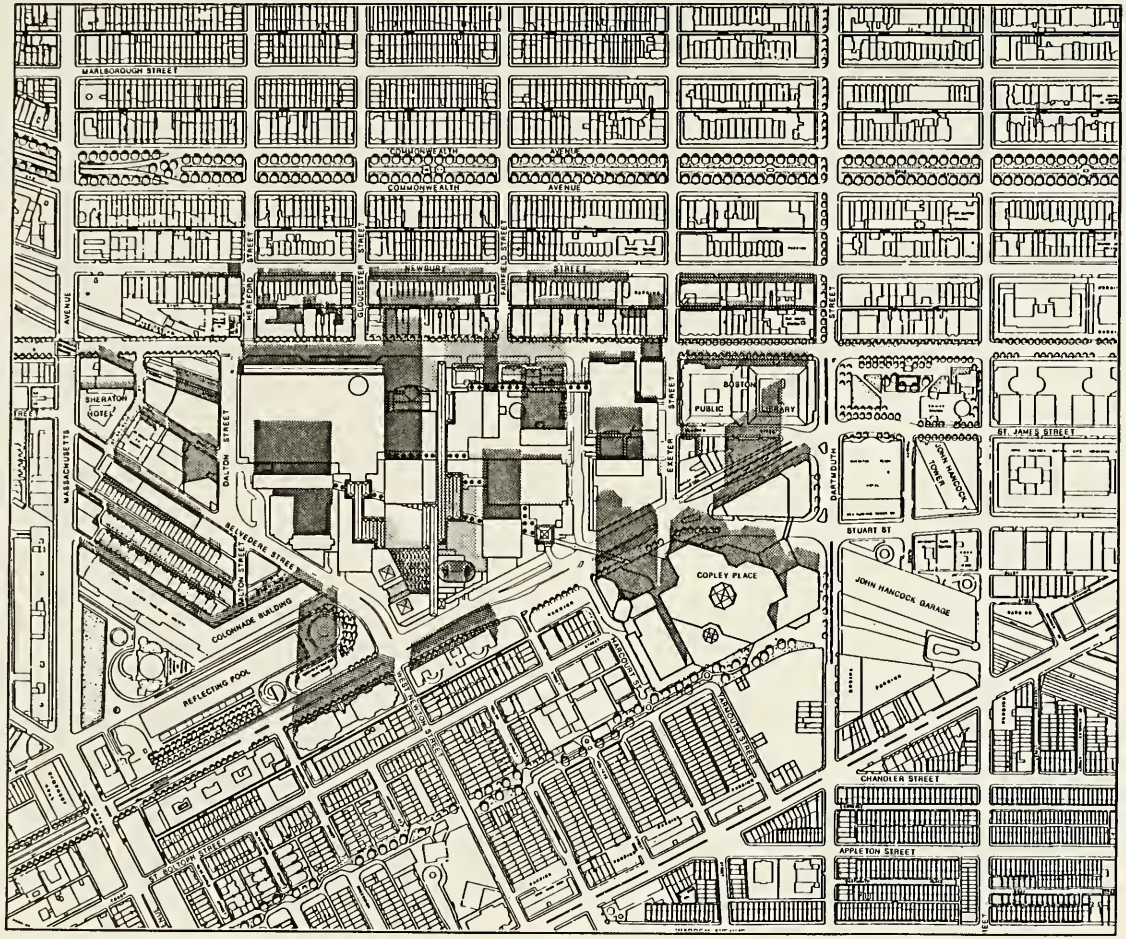
Fig. IVB-7
Horizontal Shadow Profile

Alternative A
September 23
9:00 AM EDT

EXISTING SHADOW

NET NEW SHADOW

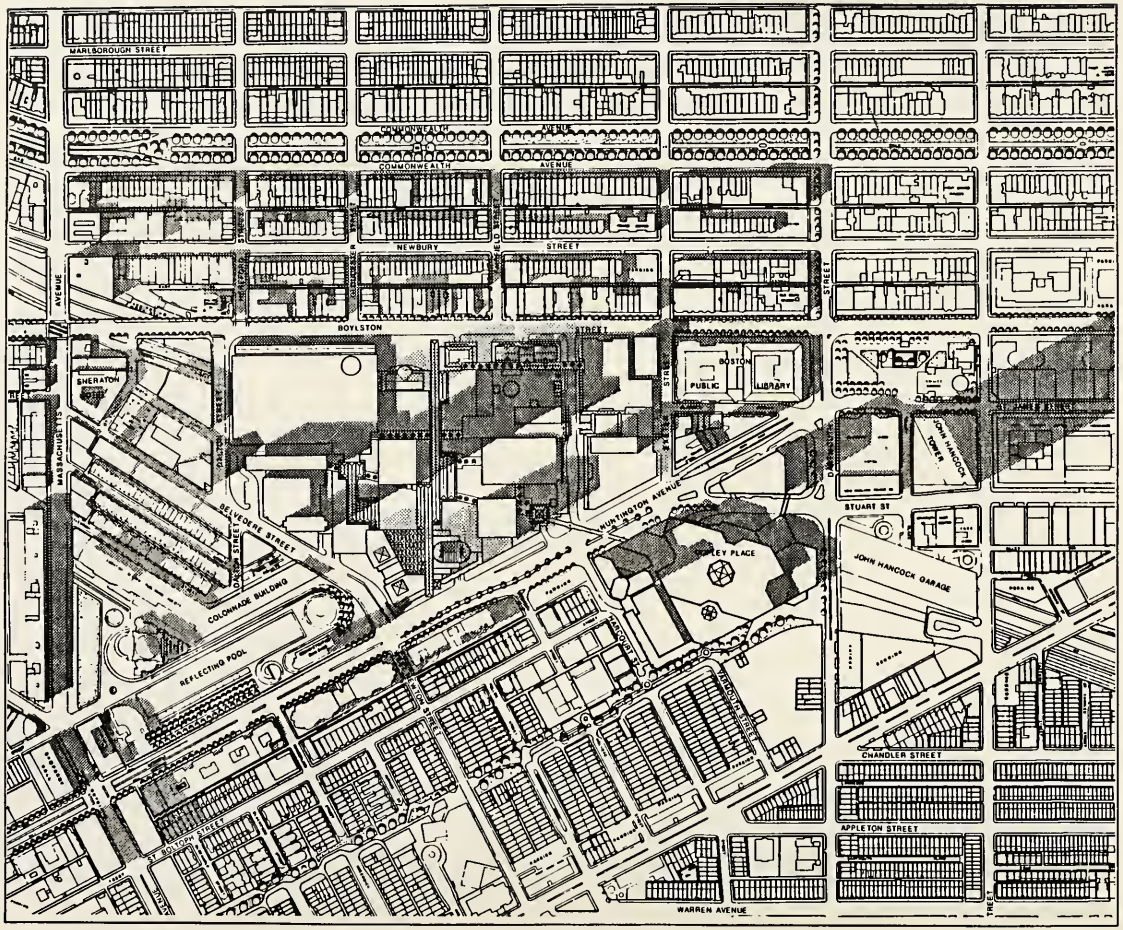
0 100 200
Scale: Feet



Prudential Center Redevelopment

Fig. IVB-8
Horizontal Shadow Profile

Alternative A
September 23
12:00 PM EDT



Prudential Center Redevelopment

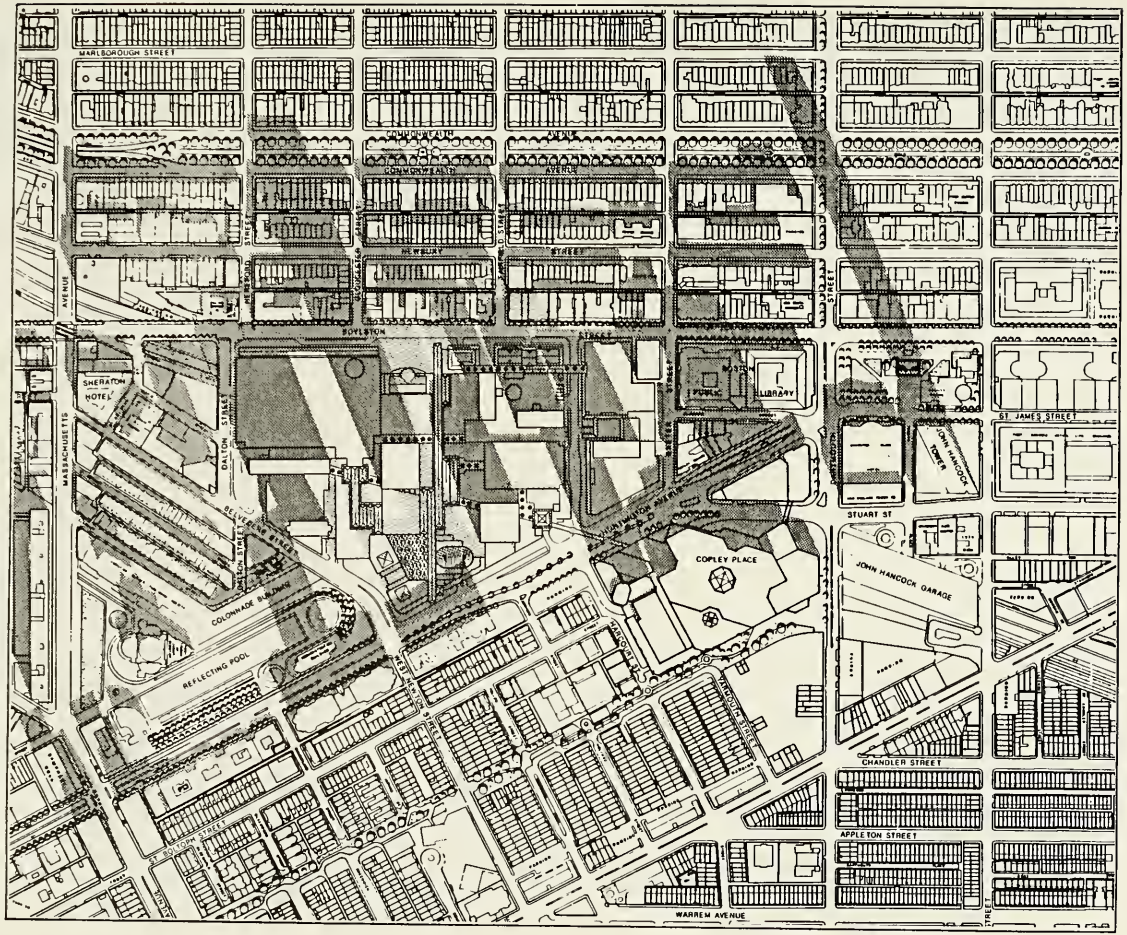
Fig. IVB-9
Horizontal Shadow Profile

Alternative A
September 23
3:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

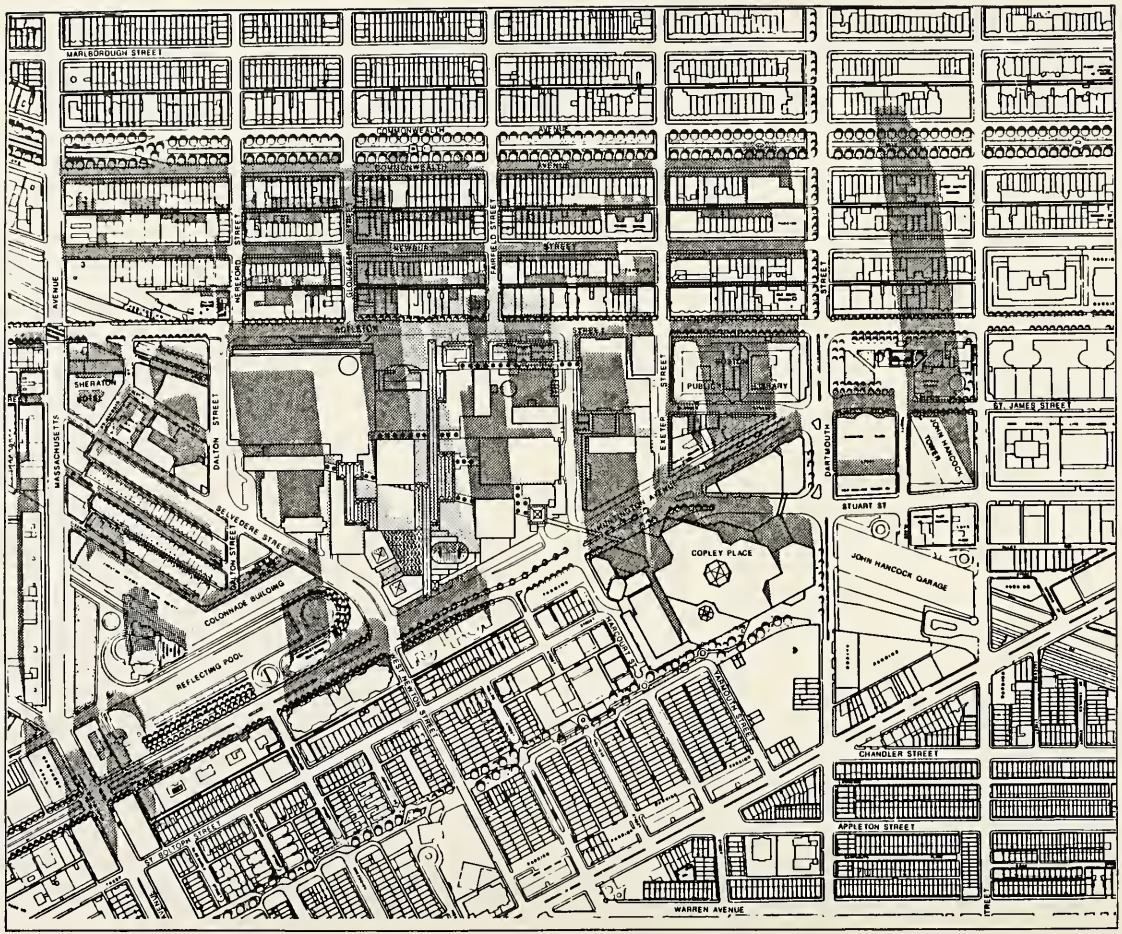
Fig. IVB-10
Horizontal Shadow Profile

Alternative A
October 21
10:00 AM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

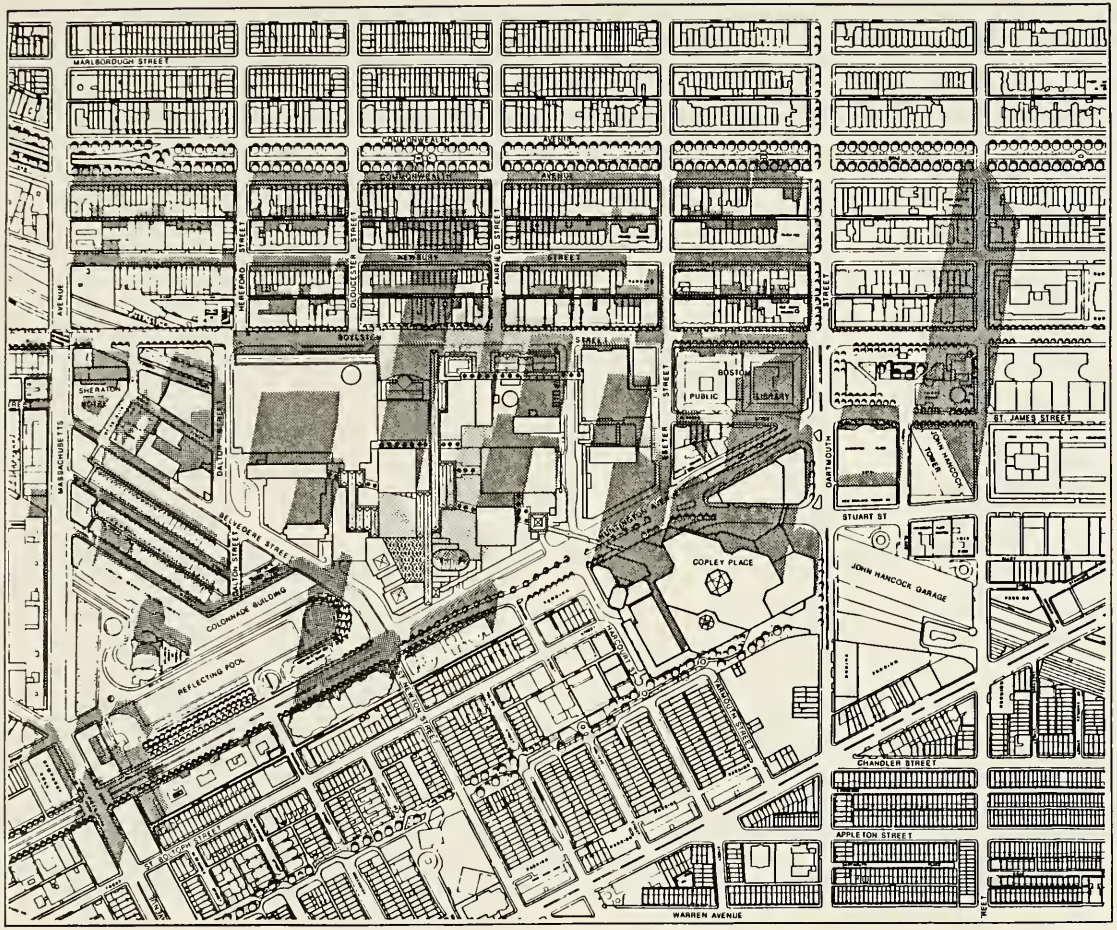
Fig. IVB-11
Horizontal Shadow Profile

Alternative A
October 21
11:00 AM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

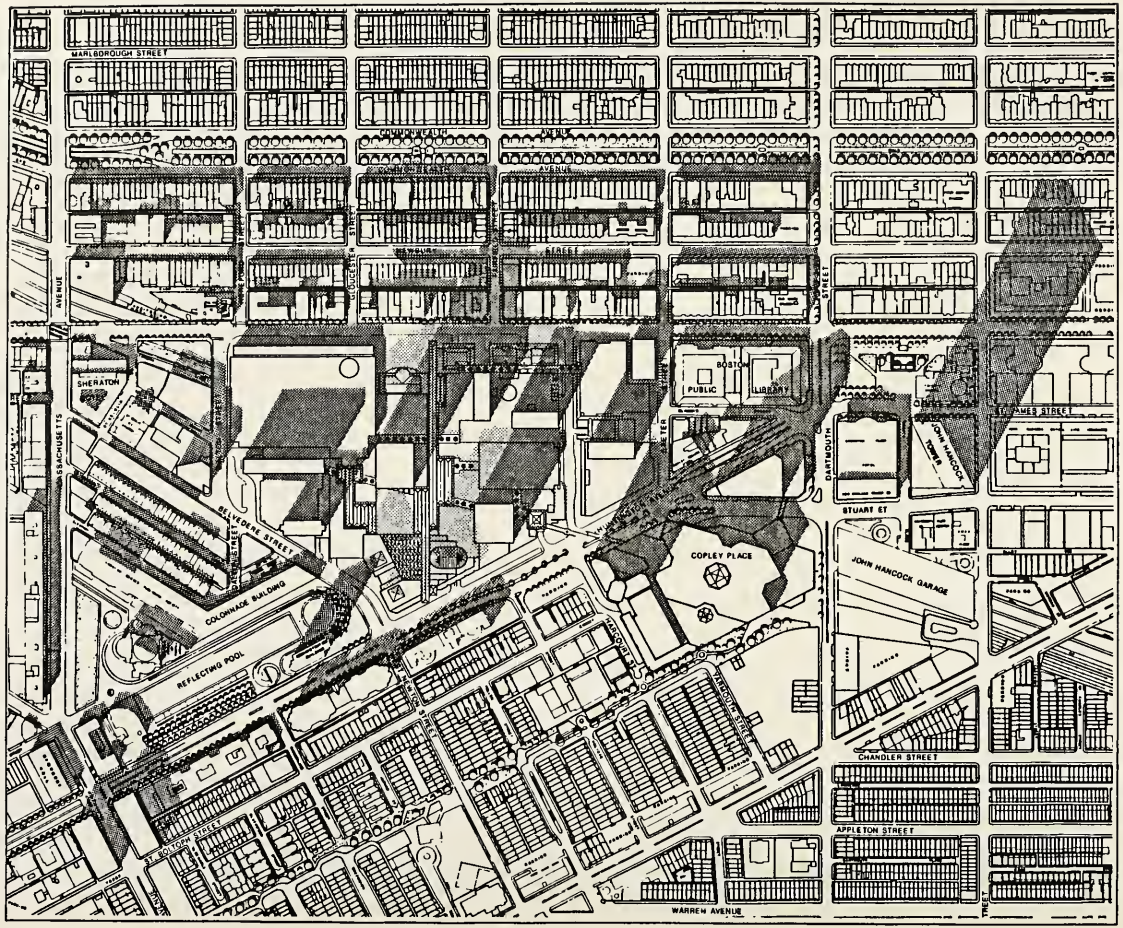
Fig. IVB-12
Horizontal Shadow Profile

Alternative A
October 21
12:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

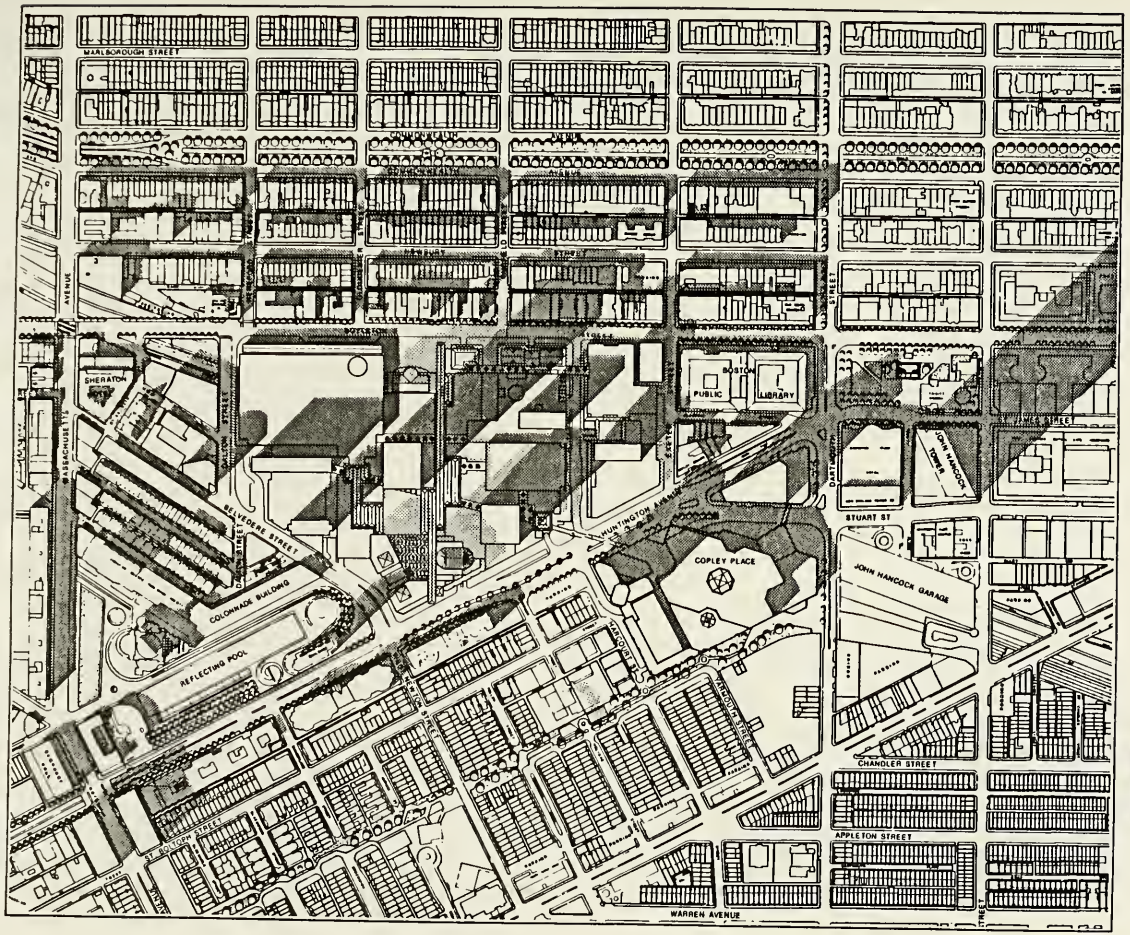
0 100 200
Scale : Feet



Prudential Center Redevelopment

Fig. IVB-13
Horizontal Shadow Profile

Alternative A
October 21
1:00 PM EDT



Prudential Center Redevelopment

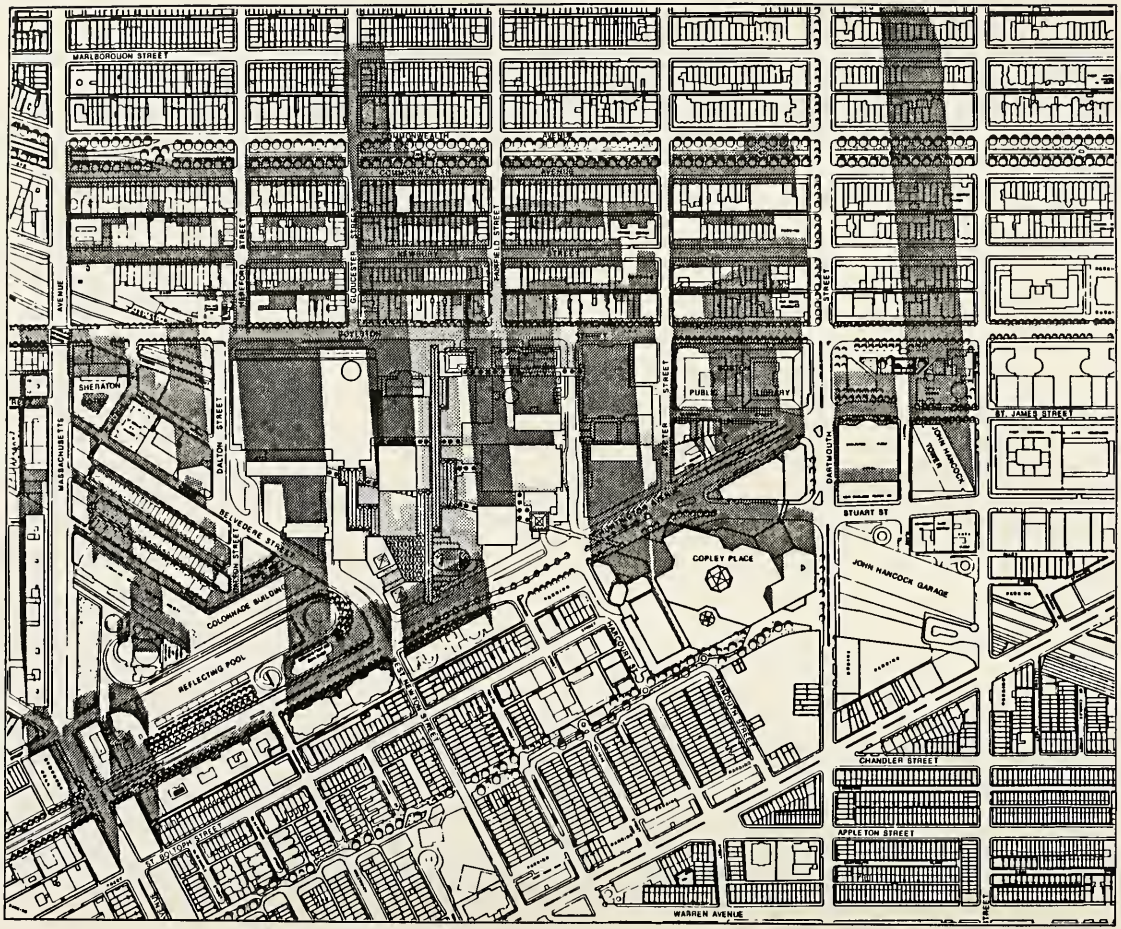
Fig. IVB-14
Horizontal Shadow Profile

Alternative A
October 21
2:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

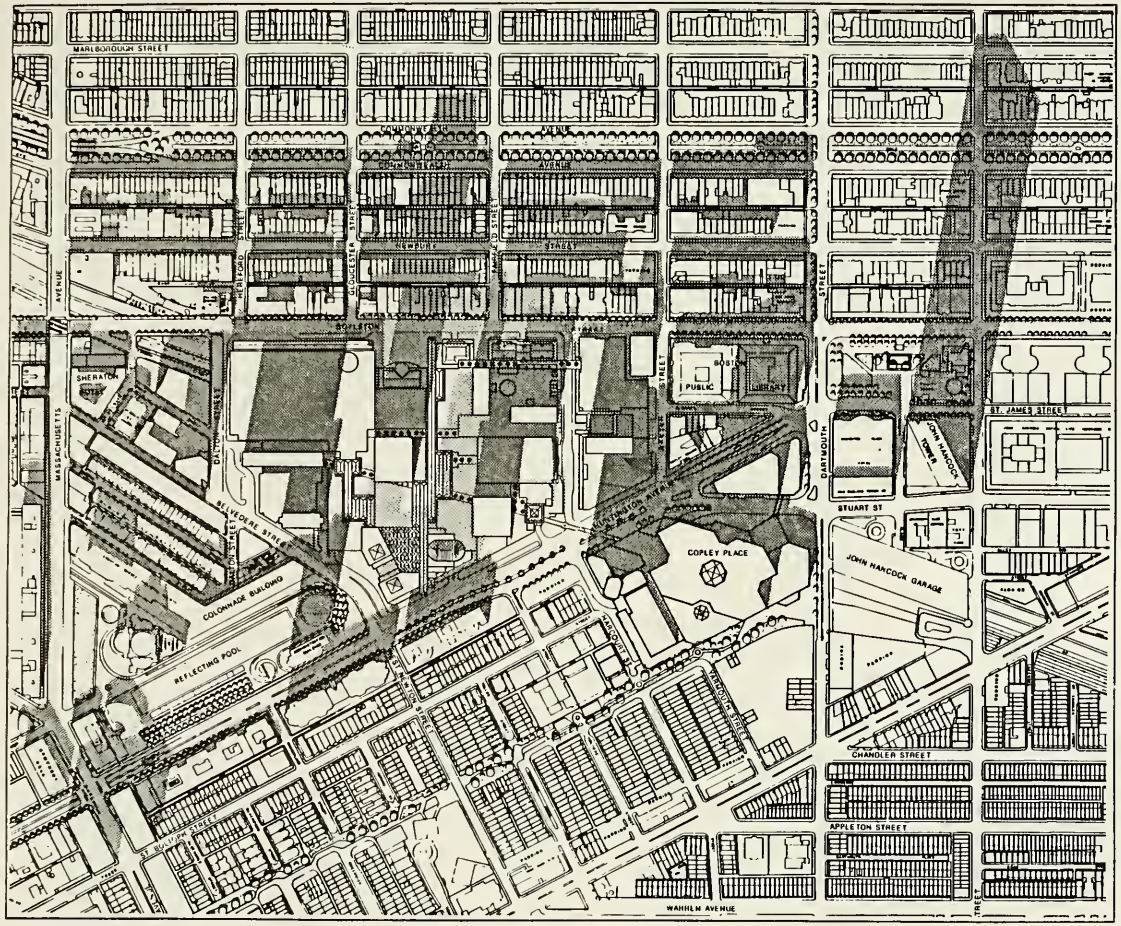
Fig. IVB-15
Horizontal Shadow Profile

Alternative A
November 21
10:00 AM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

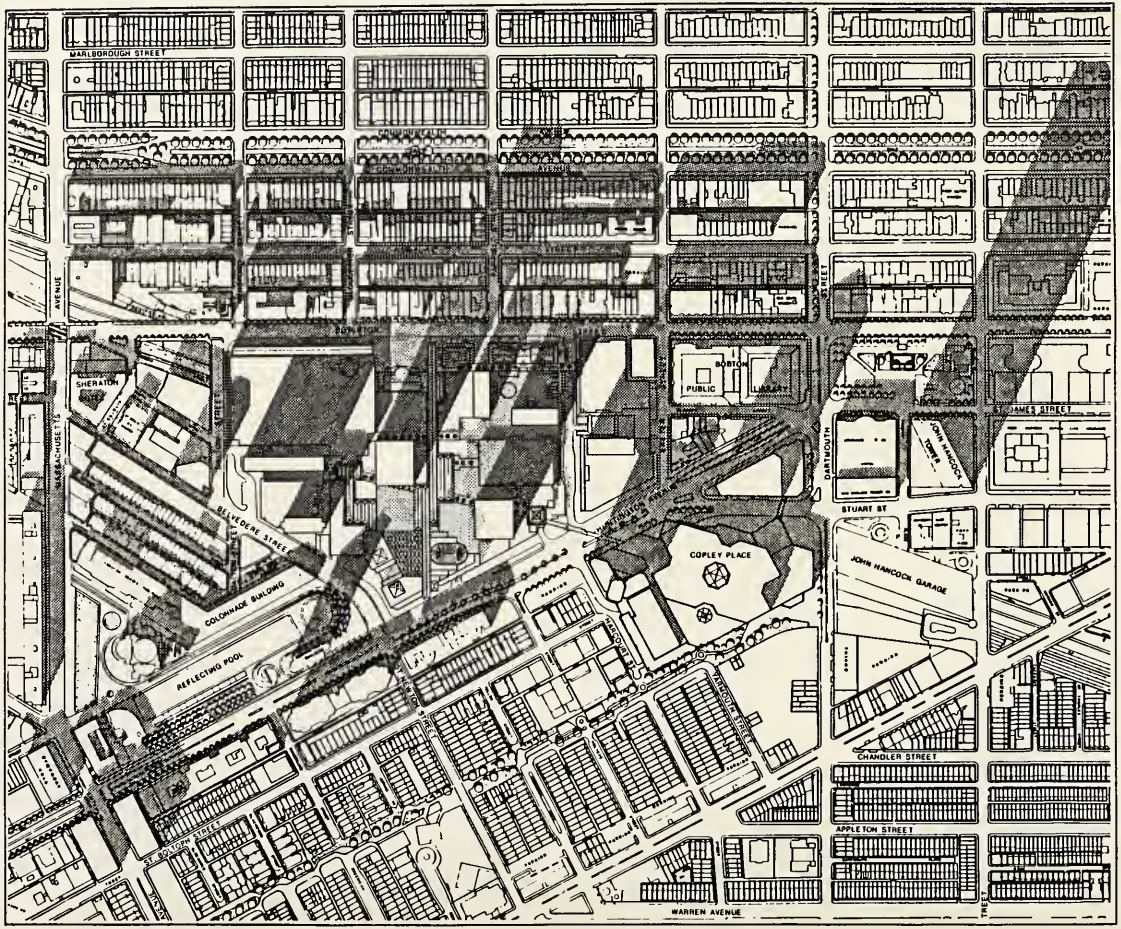
Fig. IVB-16
Horizontal Shadow Profile

Alternative A
November 21
11:00 AM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

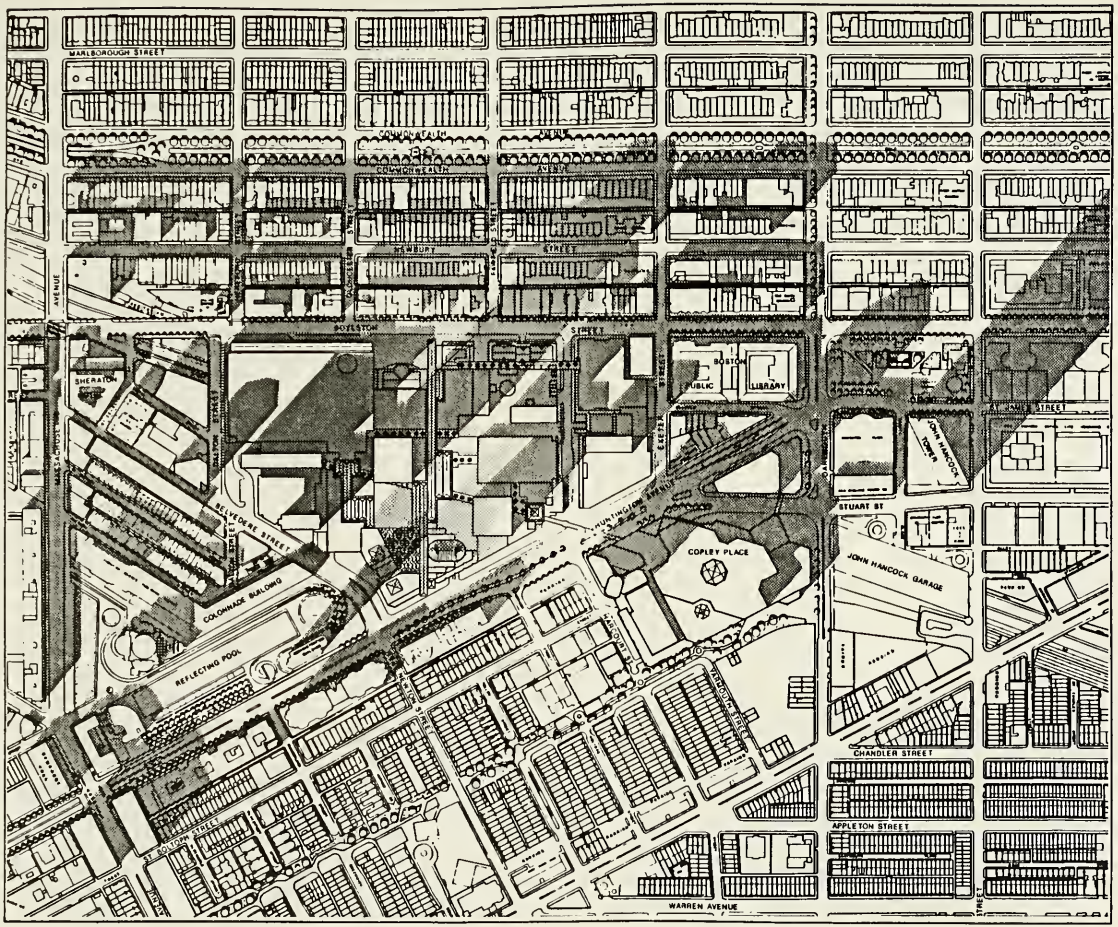
Fig. IVB-17
Horizontal Shadow Profile

Alternative A
November 21
12:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

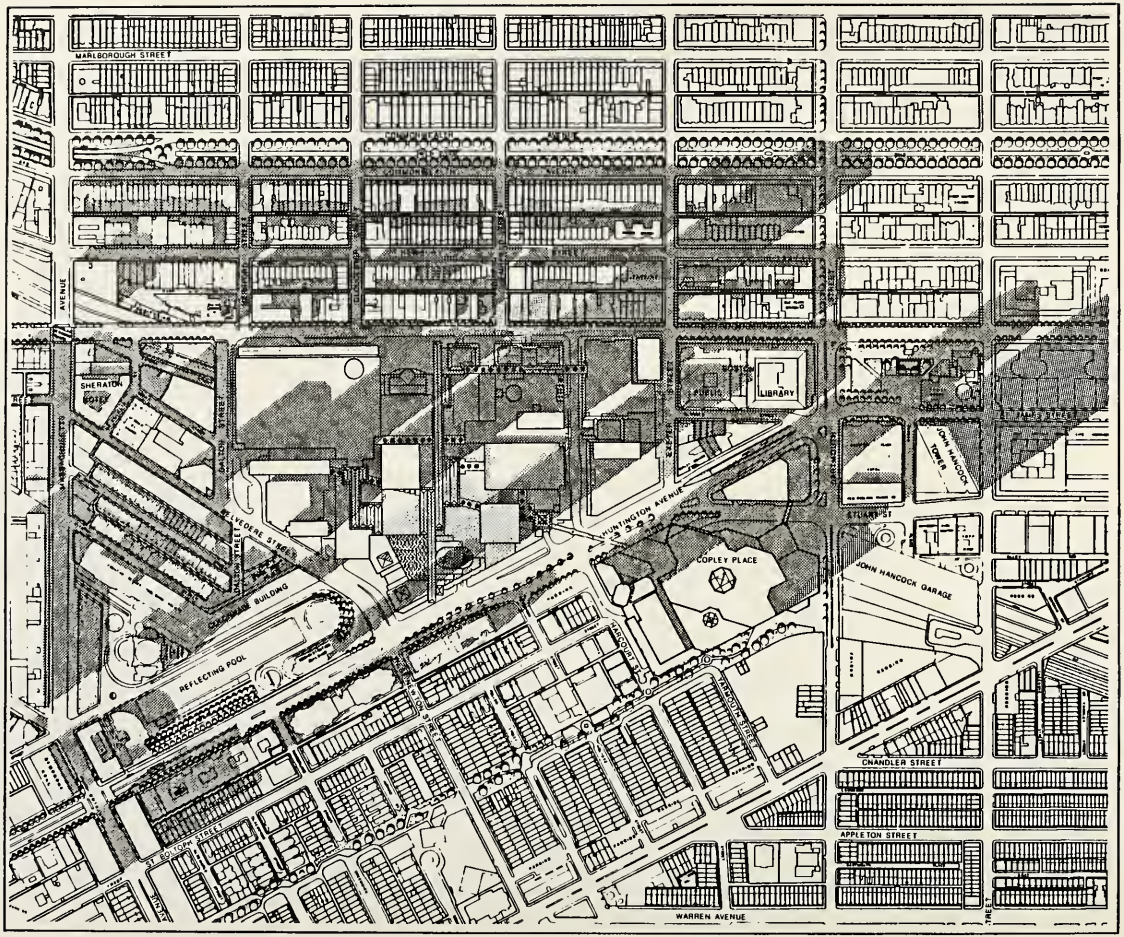
0 100 200
Scale : Feet



Prudential Center Redevelopment

Fig. IVB-18
Horizontal Shadow Profile

Alternative A
November 21
1:00 PM EST



Prudential Center Redevelopment

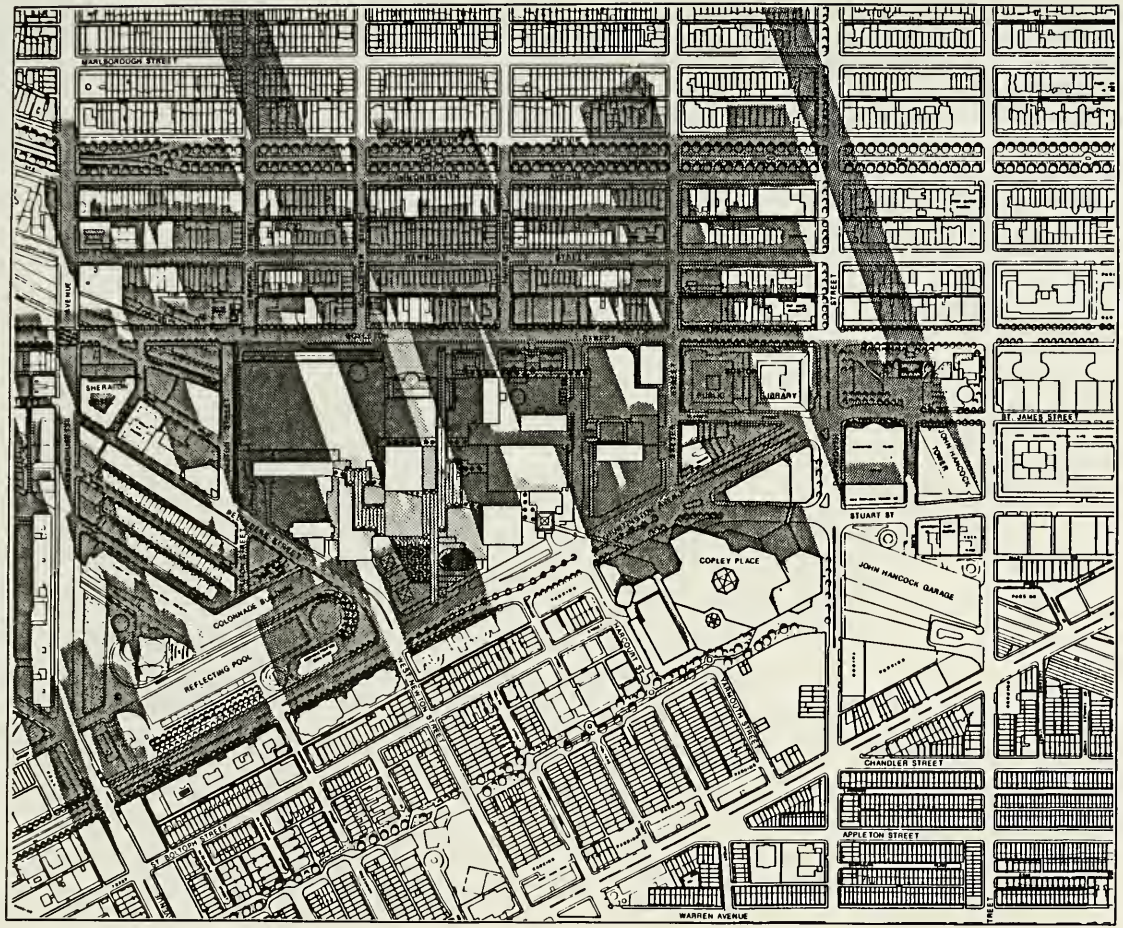
Fig. IVB-19
Horizontal Shadow Profile

Alternative A
November 21
2:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

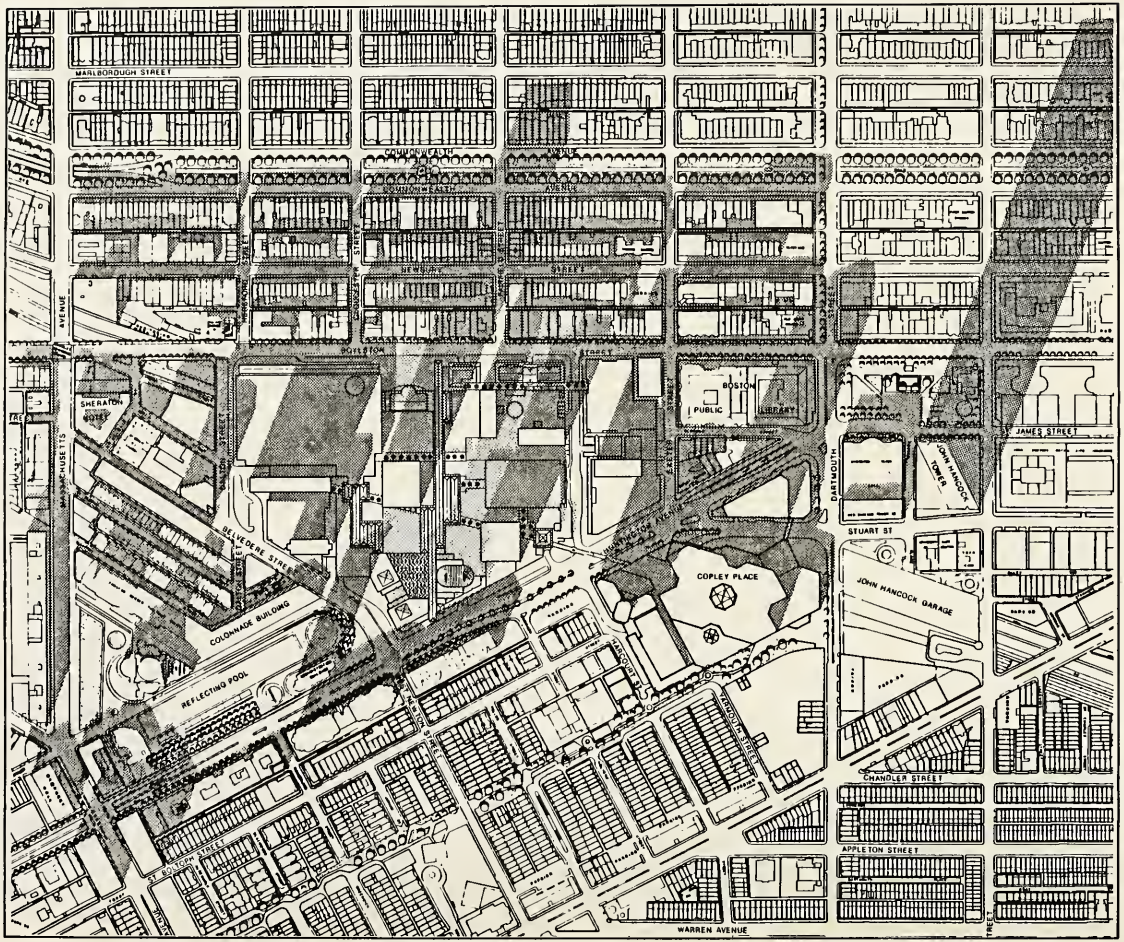
Fig. IVB-20
Horizontal Shadow Profile

Alternative A
December 22
9:00 AM EST

EXISTING SHADOW

NET NEW SHADOW

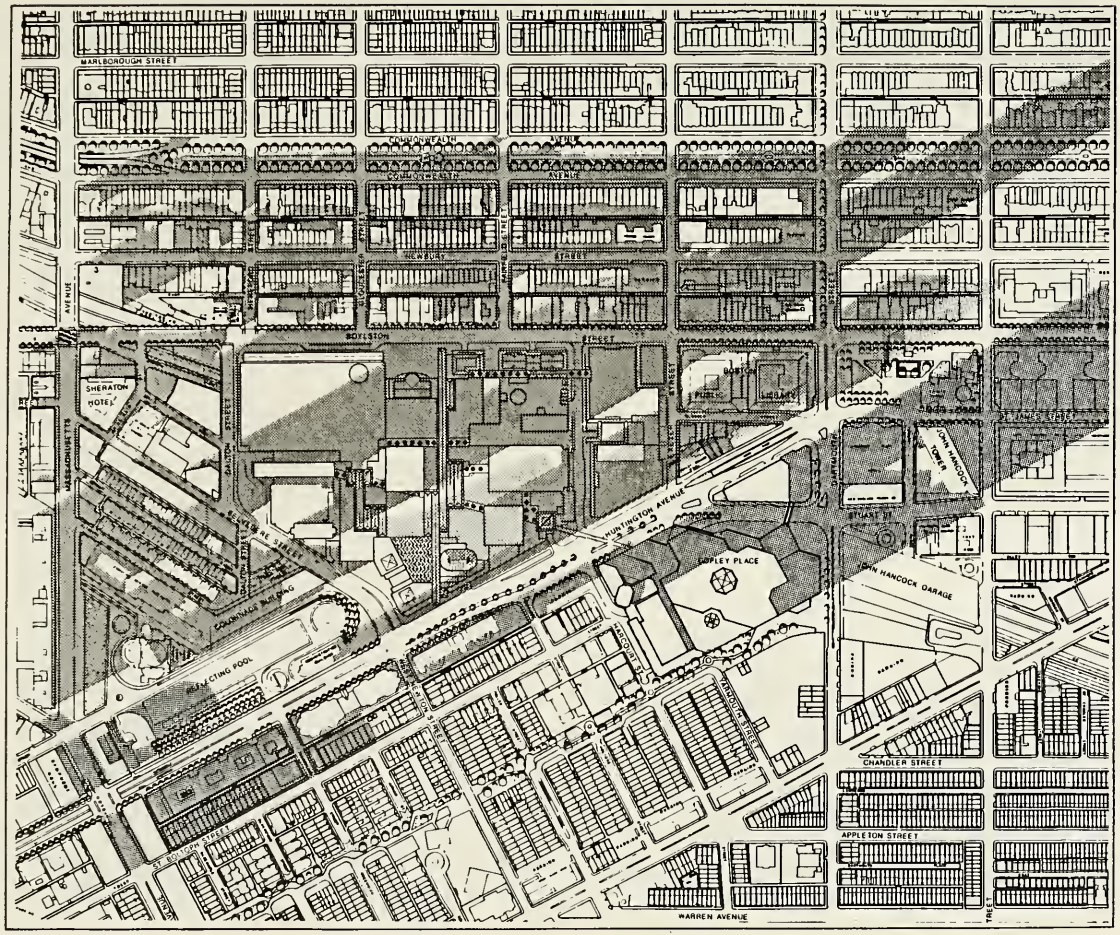
0 100 200
Scale: Feet



Prudential Center Redevelopment

Fig. IVB-21
Horizontal Shadow Profile

Alternative A
December 22
12:00 PM EST



Prudential Center Redevelopment

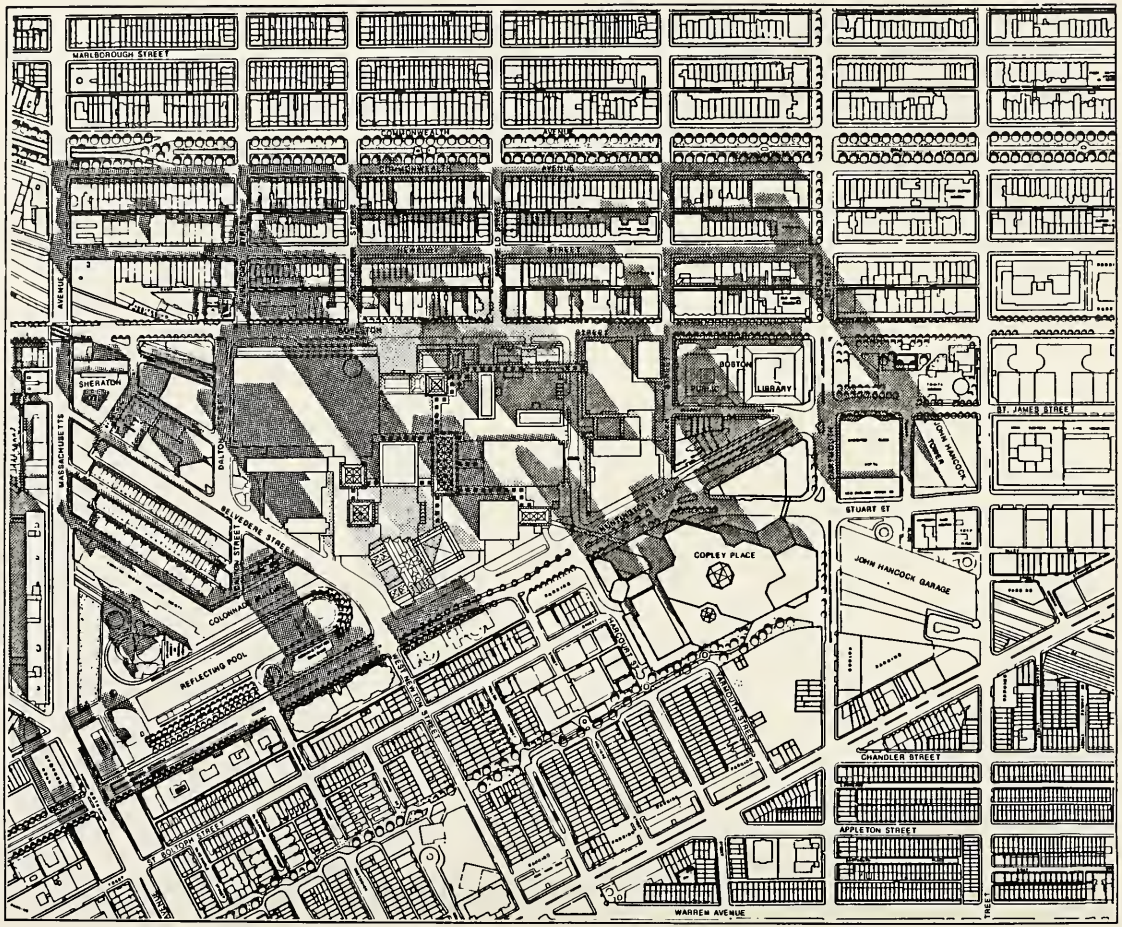
Fig. IVB-22
Horizontal Shadow Profile

Alternative A
December 22
3:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

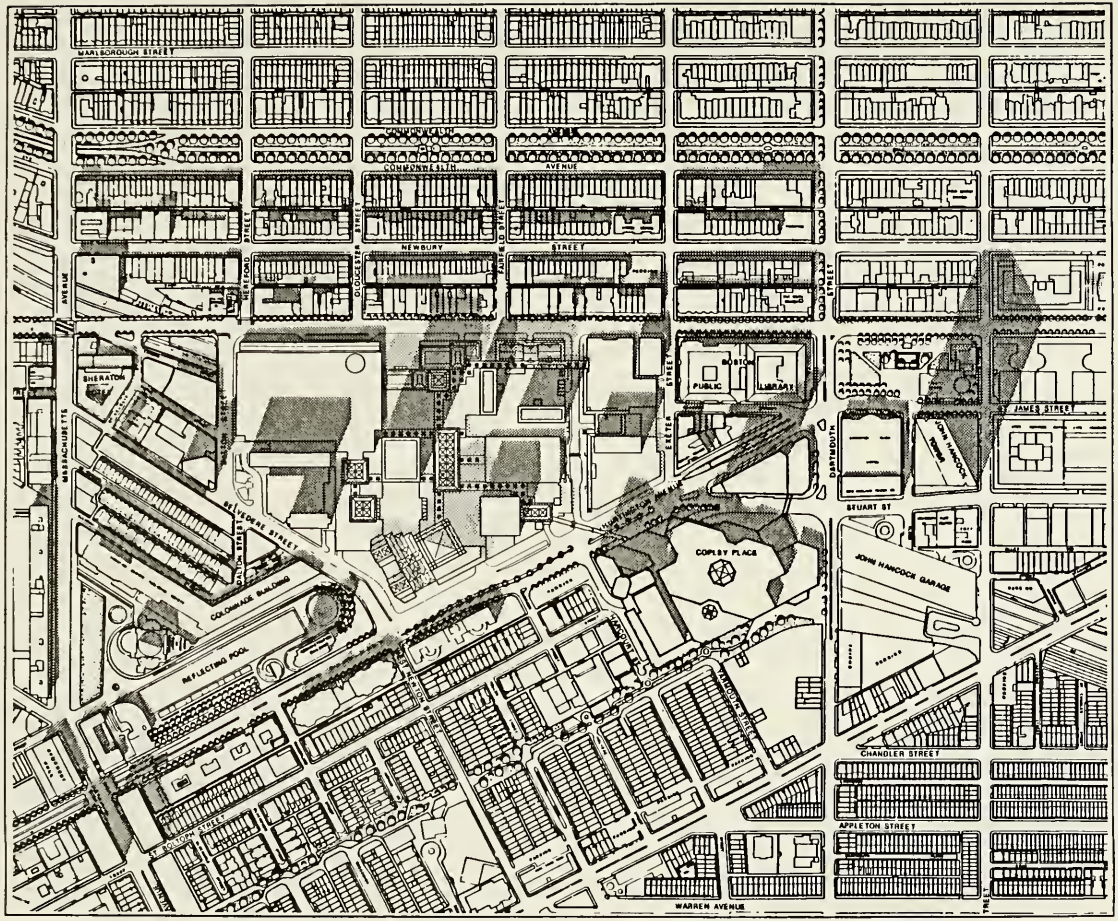
Fig. IVB-23
Horizontal Shadow Profile

Alternative A2
March 21
9:00 AM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

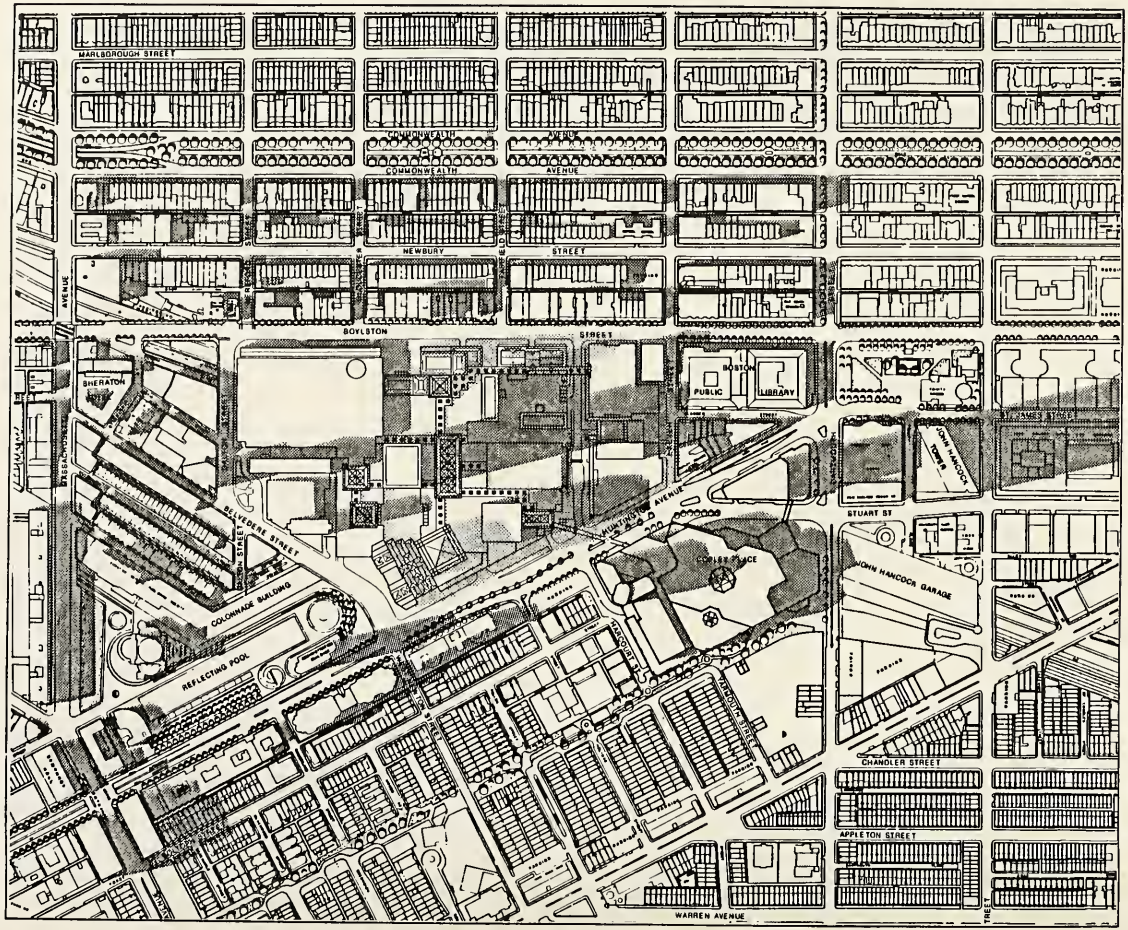
Fig. IVB-24
Horizontal Shadow Profile

Alternative A2
March 21
12:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

Fig. IVB-25
Horizontal Shadow Profile

Alternative A2
March 21
3:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet

Prudential Center Redevelopment

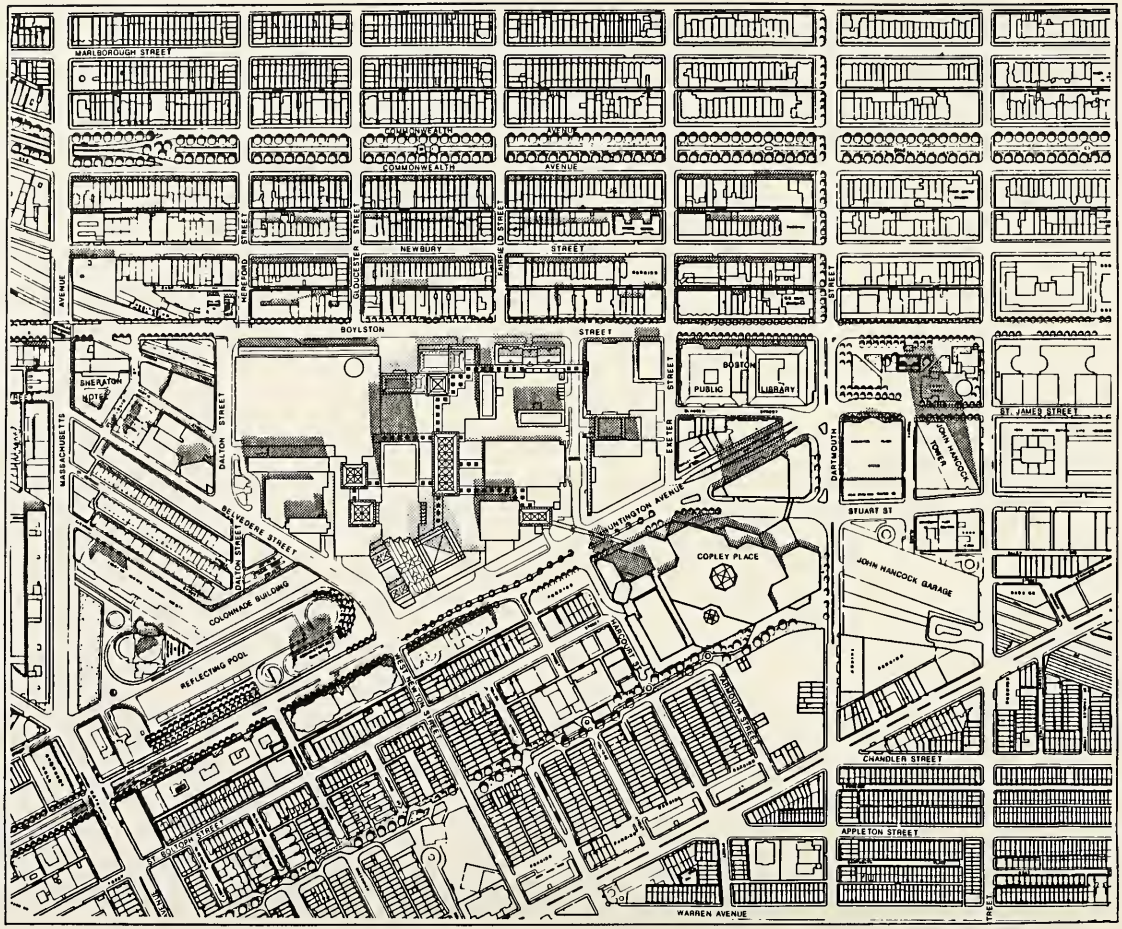
Fig. IVB-26
Horizontal Shadow Profile

Alternative A2
June 22
9:00 AM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

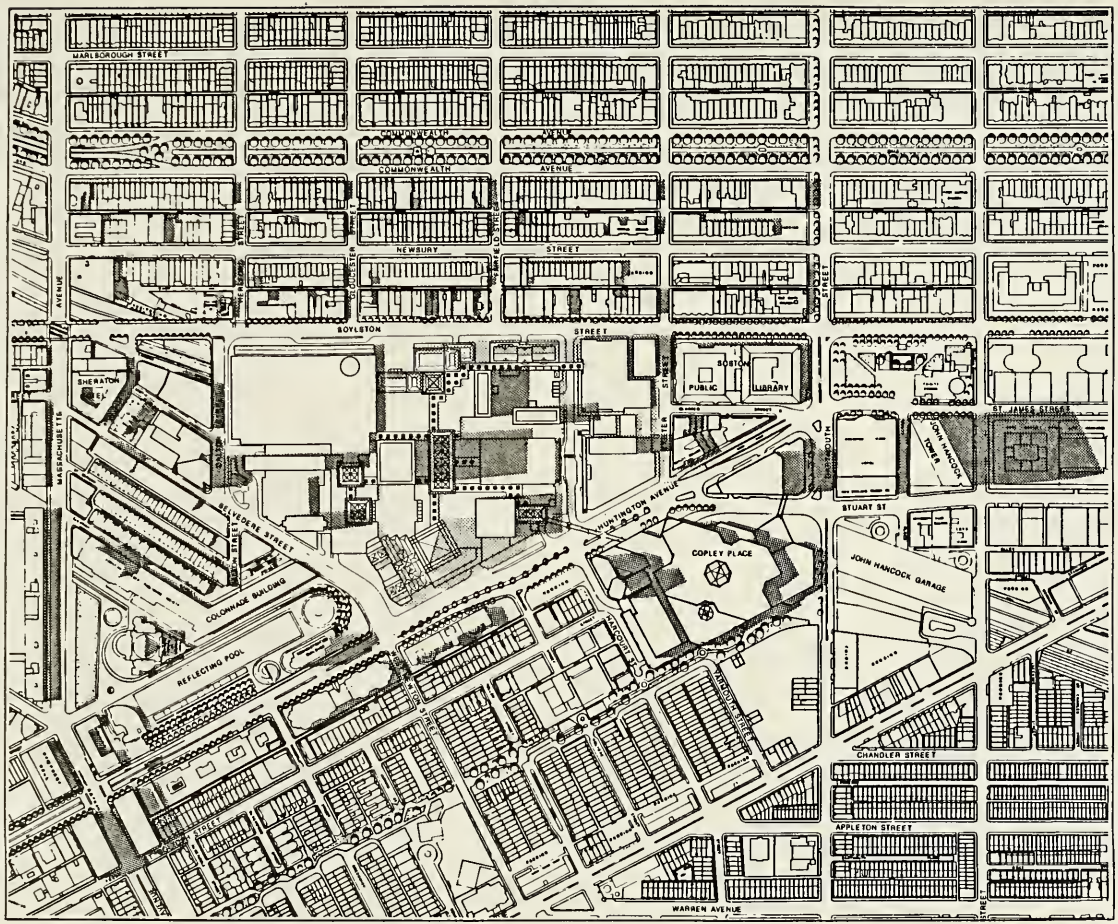
Fig. IVB-27
Horizontal Shadow Profile

Alternative A2
June 22
12:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

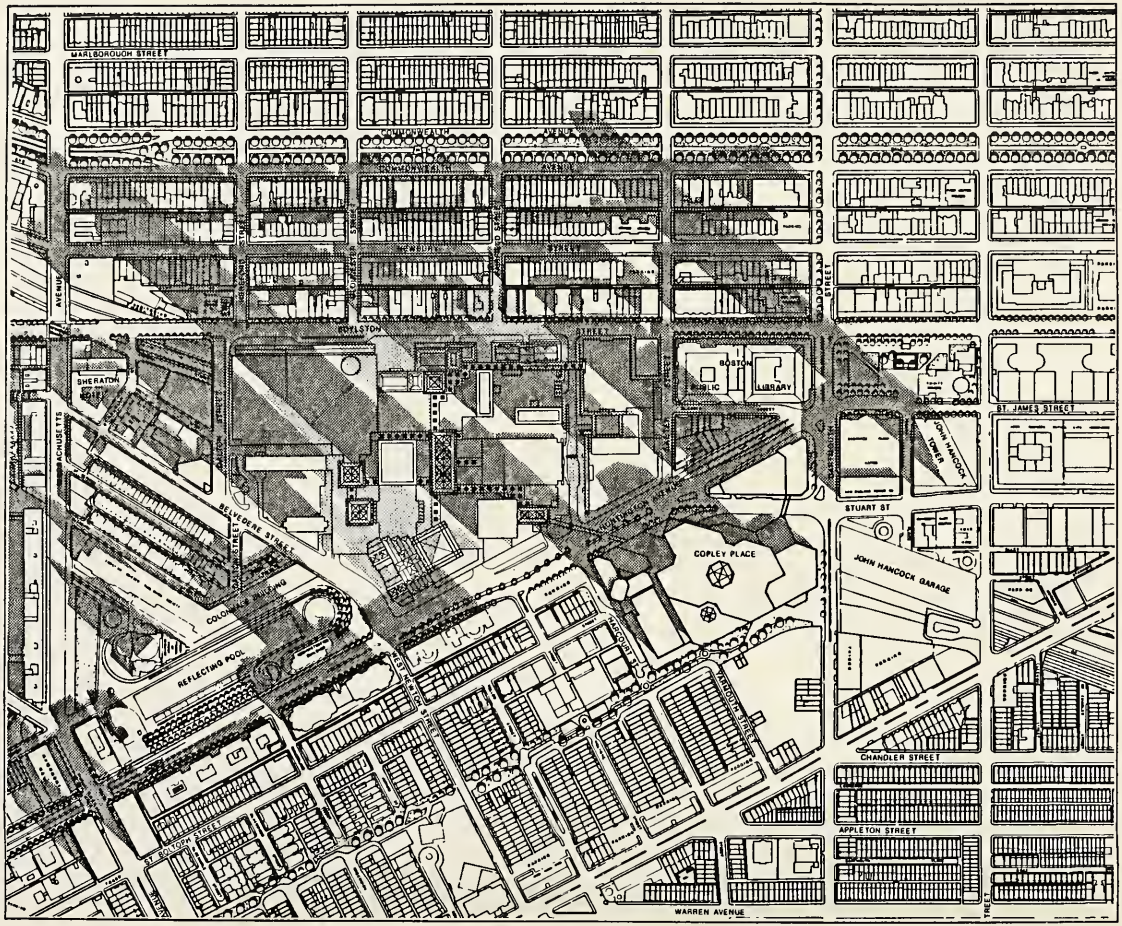
Fig. IVB-28
Horizontal Shadow Profile

Alternative A2
June 22
3:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

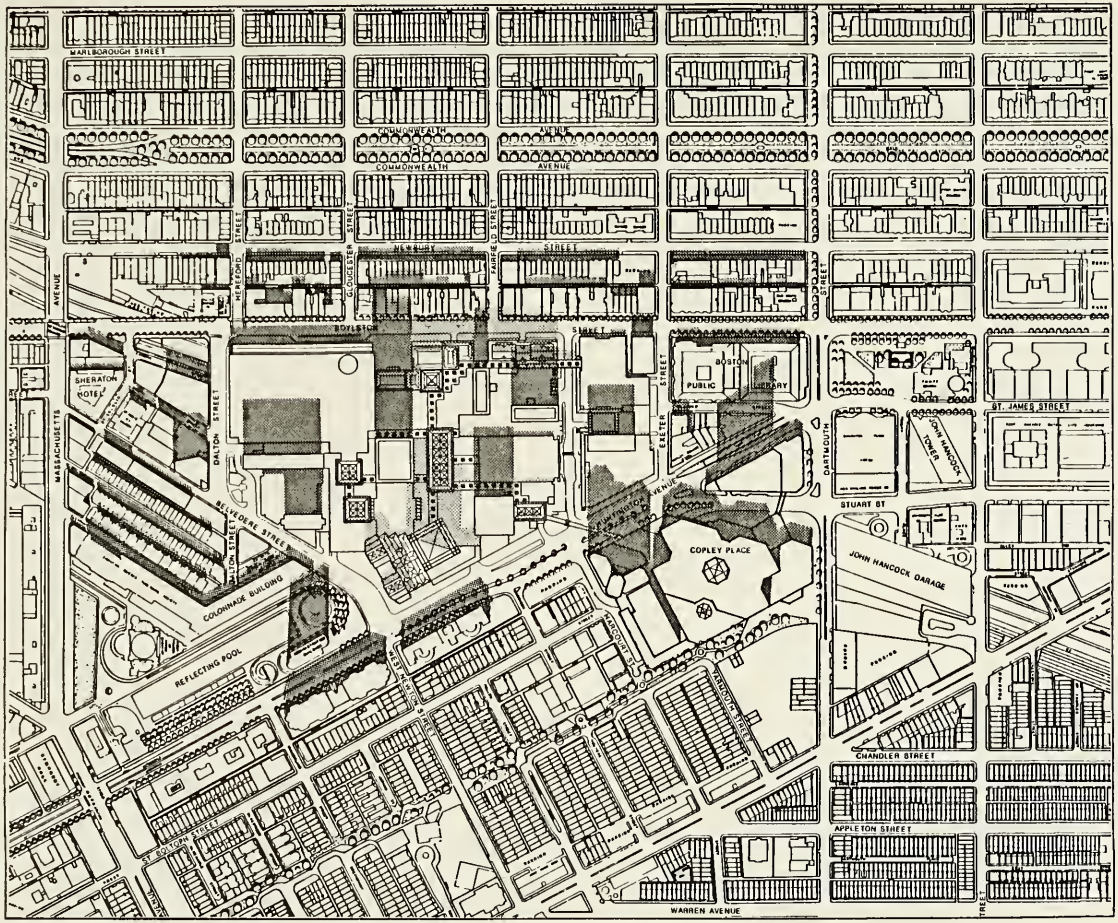
Fig. IVB-29
Horizontal Shadow Profile

Alternative A2
September 23
9:00 AM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

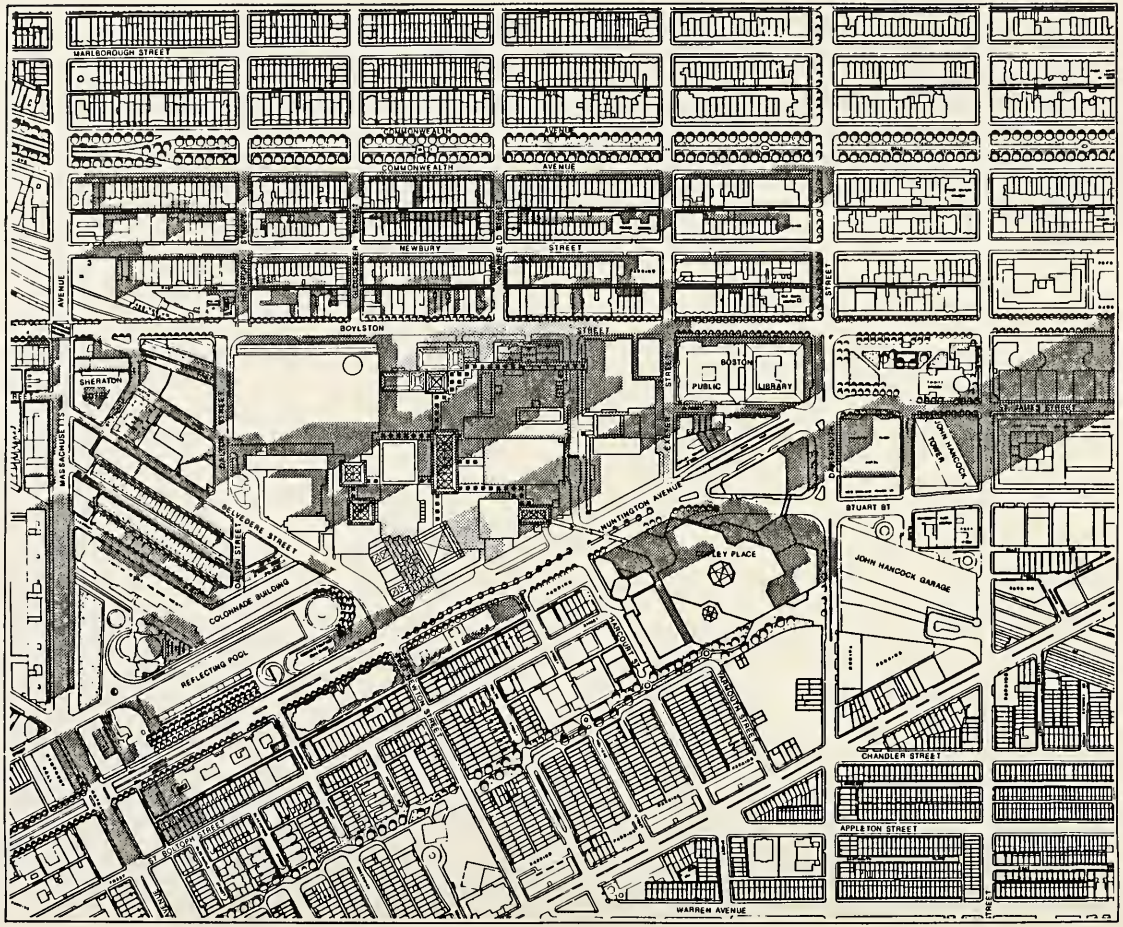
Fig. IVB-30
Horizontal Shadow Profile

Alternative A2
September 23
12:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

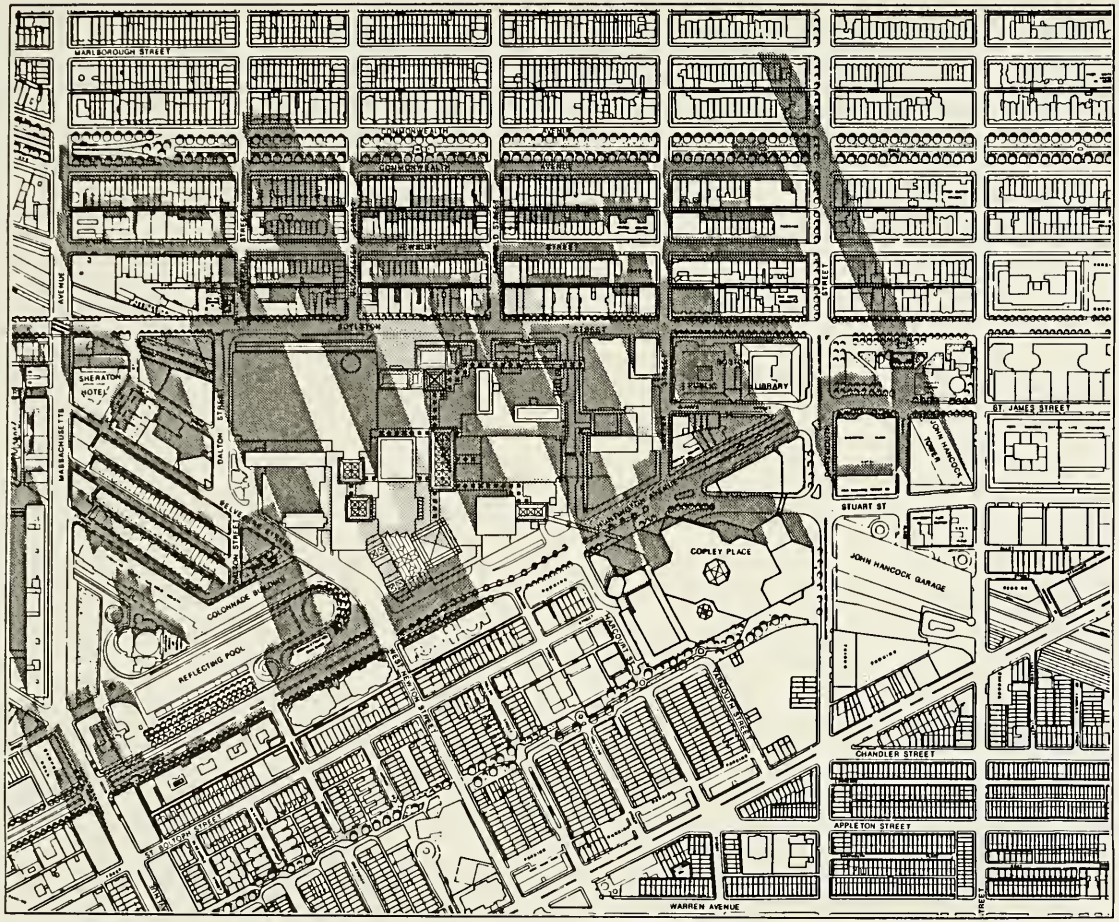
Fig. IVB-31
Horizontal Shadow Profile

Alternative A2
September 23
3:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

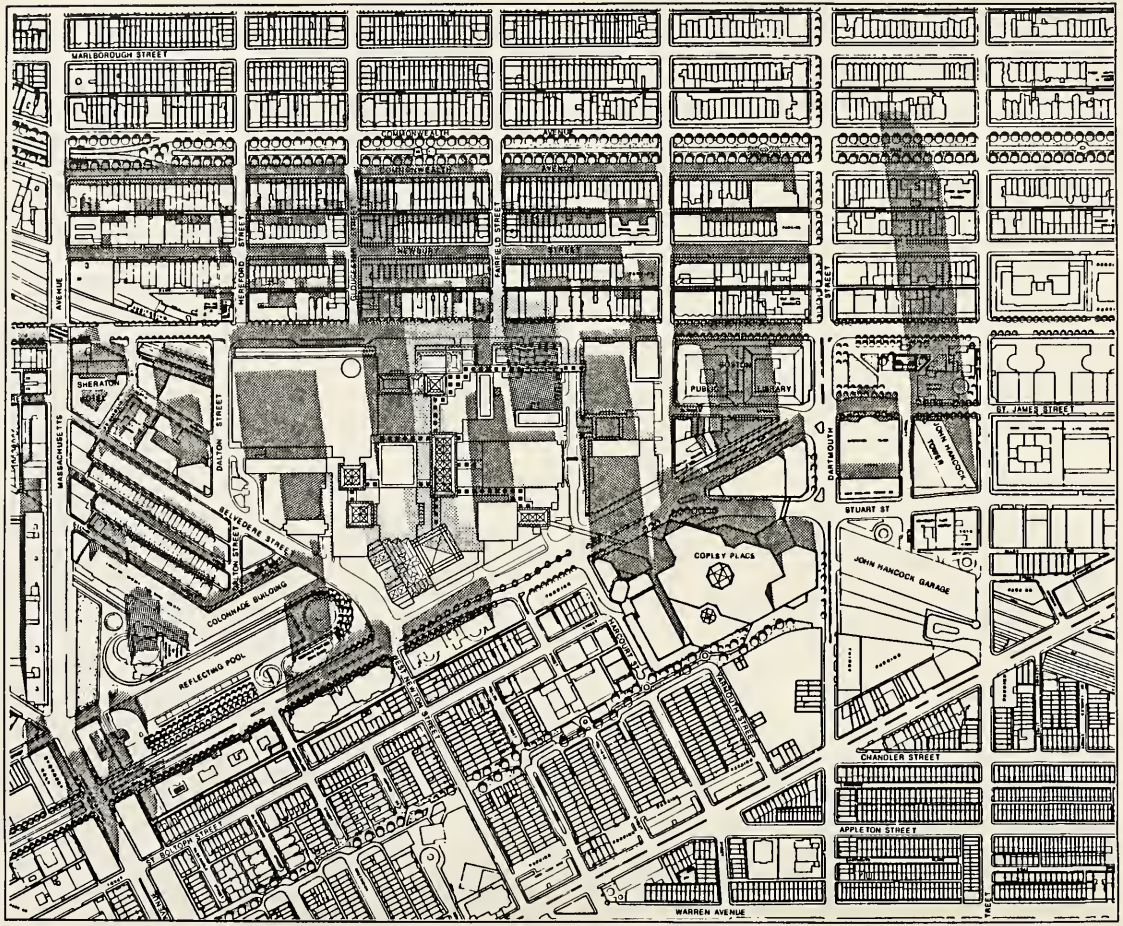
Fig. IVB-32
Horizontal Shadow Profile

Alternative A2
October 21
10:00 AM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

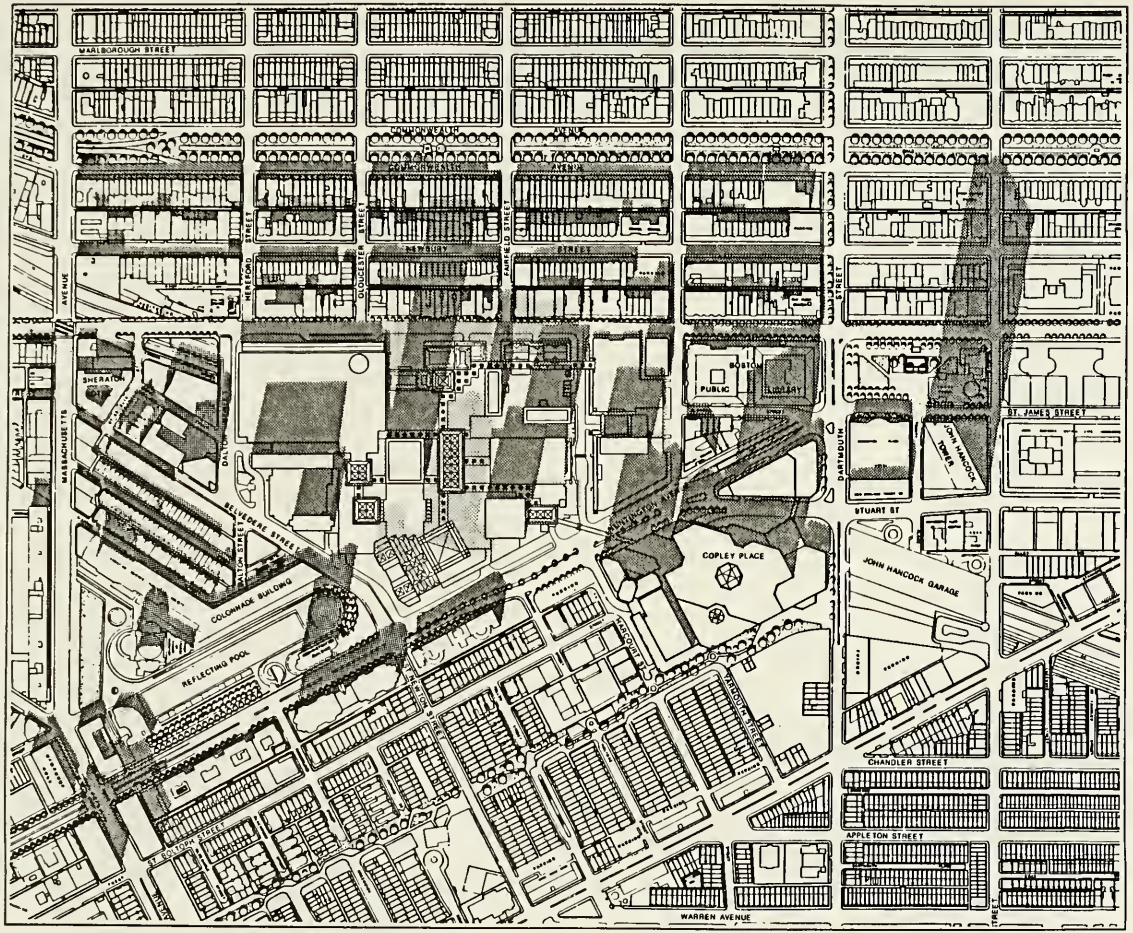
Fig. IVB-33
Horizontal Shadow Profile

Alternative A2
October 21
11:00 AM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

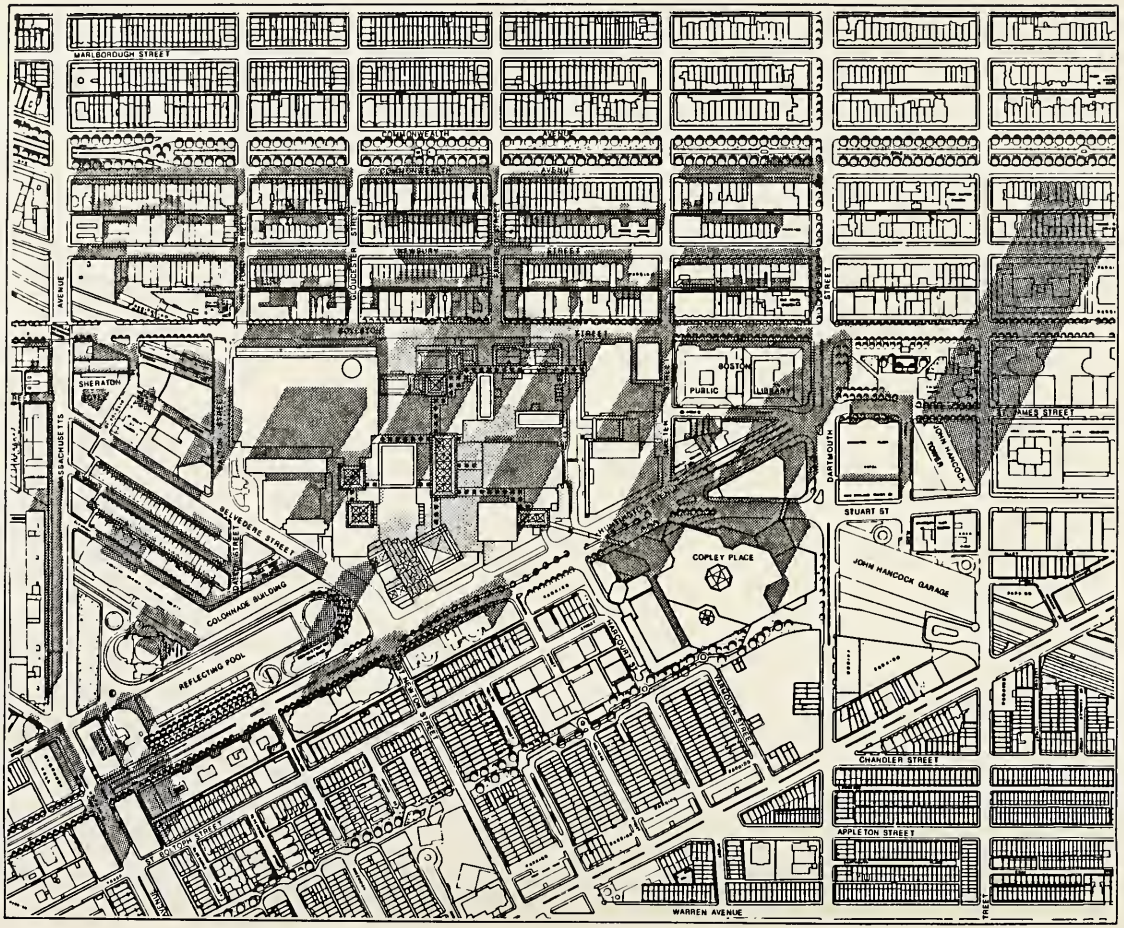
Fig. IVB-34
Horizontal Shadow Profile

Alternative A2
October 21
12:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

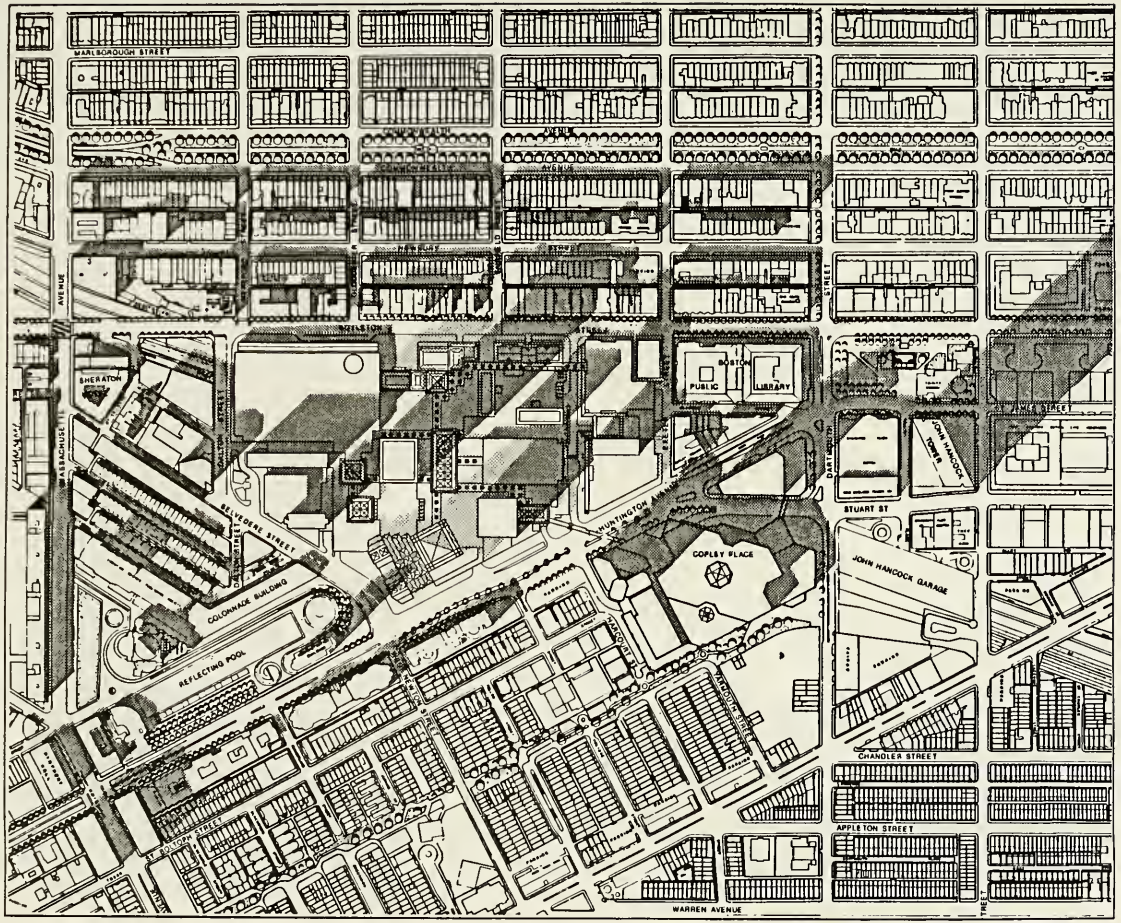
Fig. IVB-35
Horizontal Shadow Profile

Alternative A2
October 21
1:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

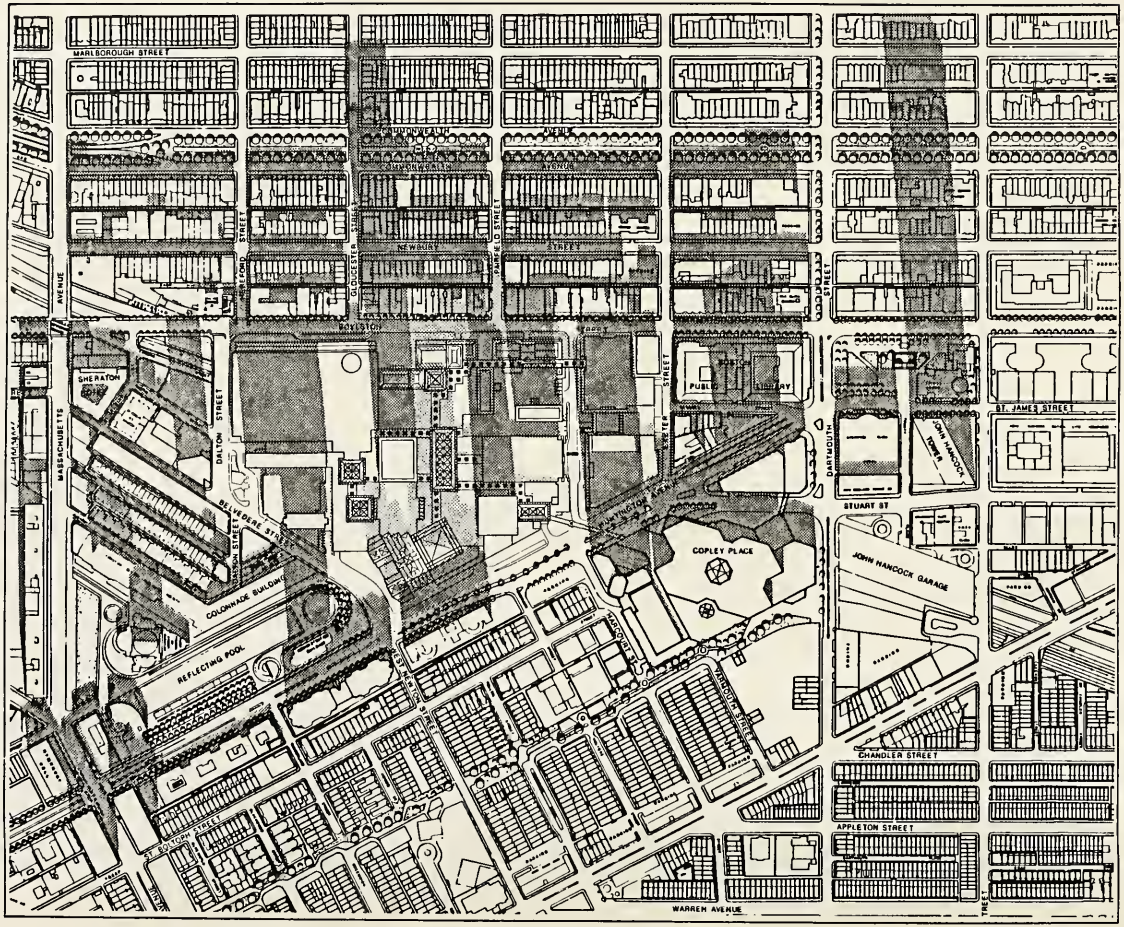
Fig. IVB-36
Horizontal Shadow Profile

Alternative A2
October 21
2:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

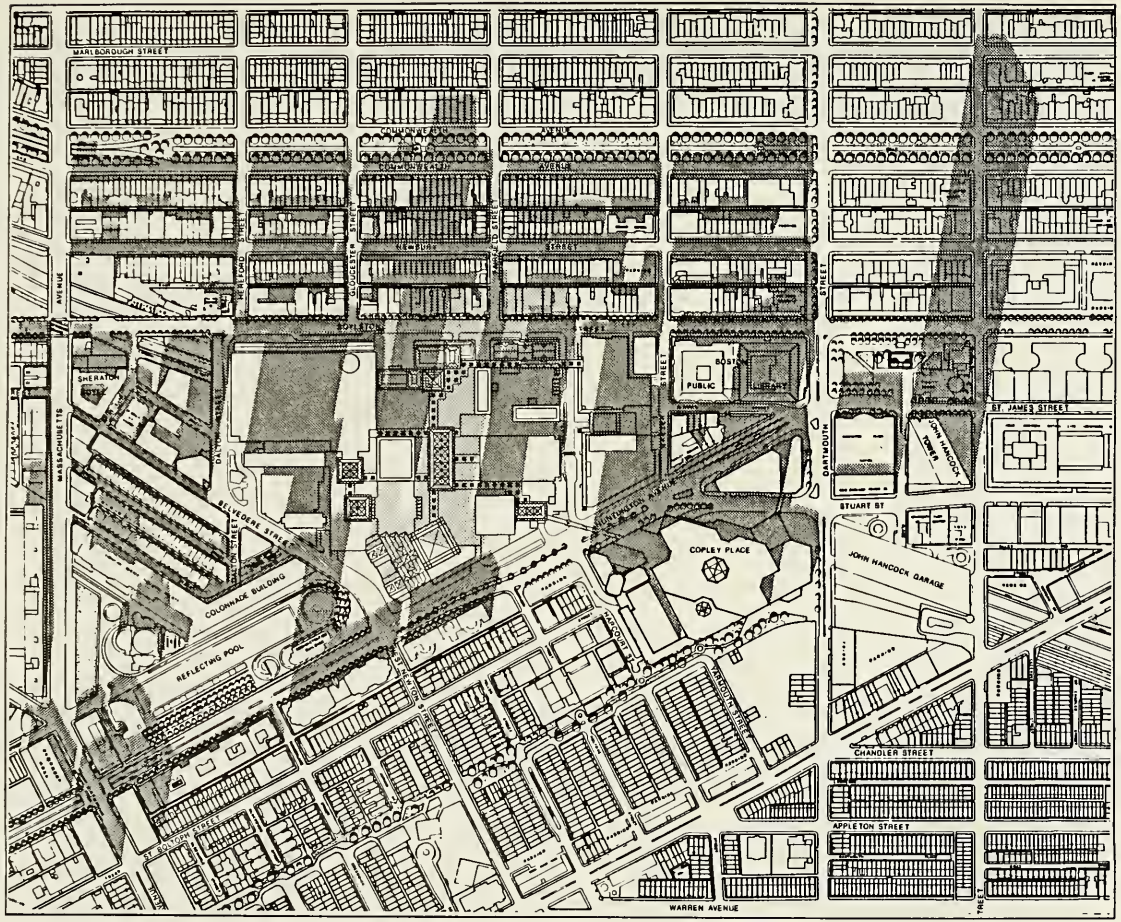
0 100 200
Scale : Feet



Prudential Center Redevelopment

Fig. IVB-37
Horizontal Shadow Profile

Alternative A2
November 21
10:00 AM EST



Prudential Center Redevelopment

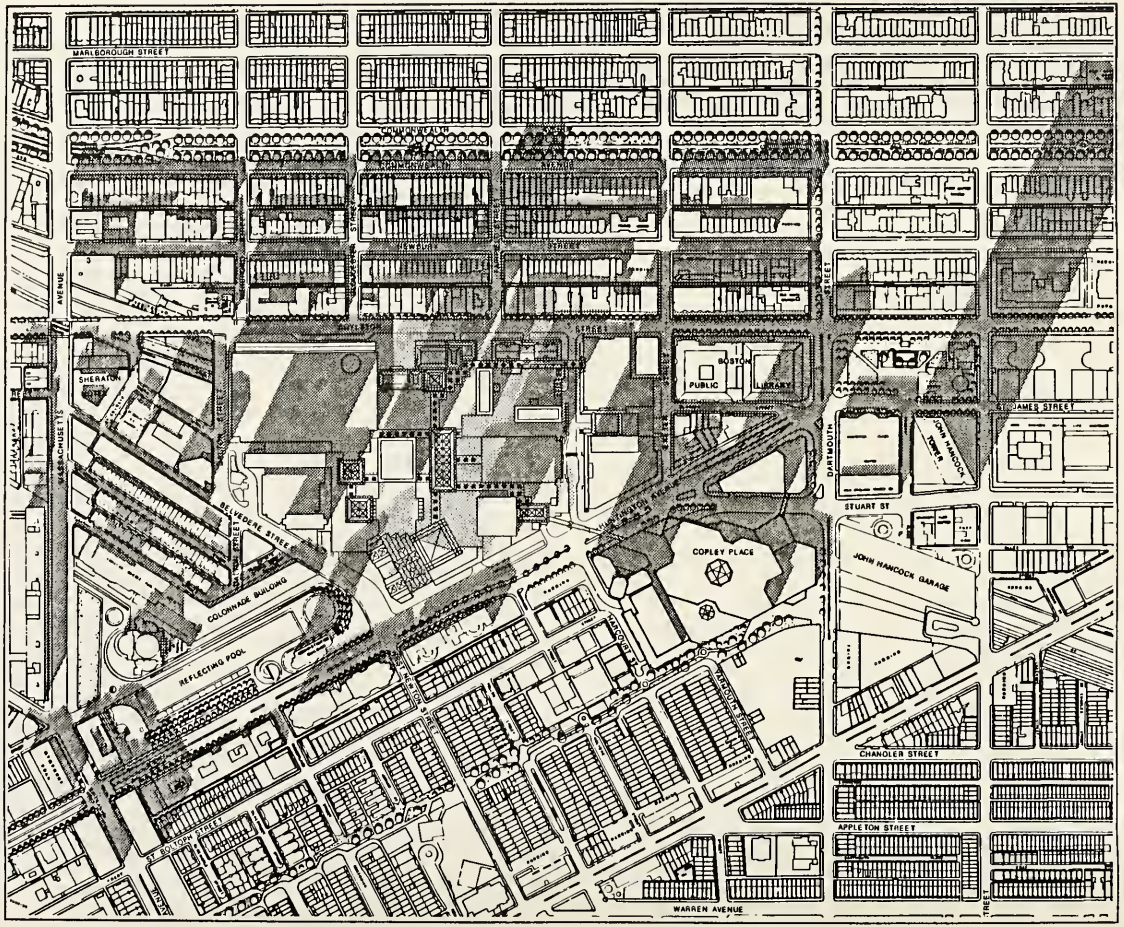
Fig. IVB-38
Horizontal Shadow Profile

Alternative A2
November 21
11:00 AM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

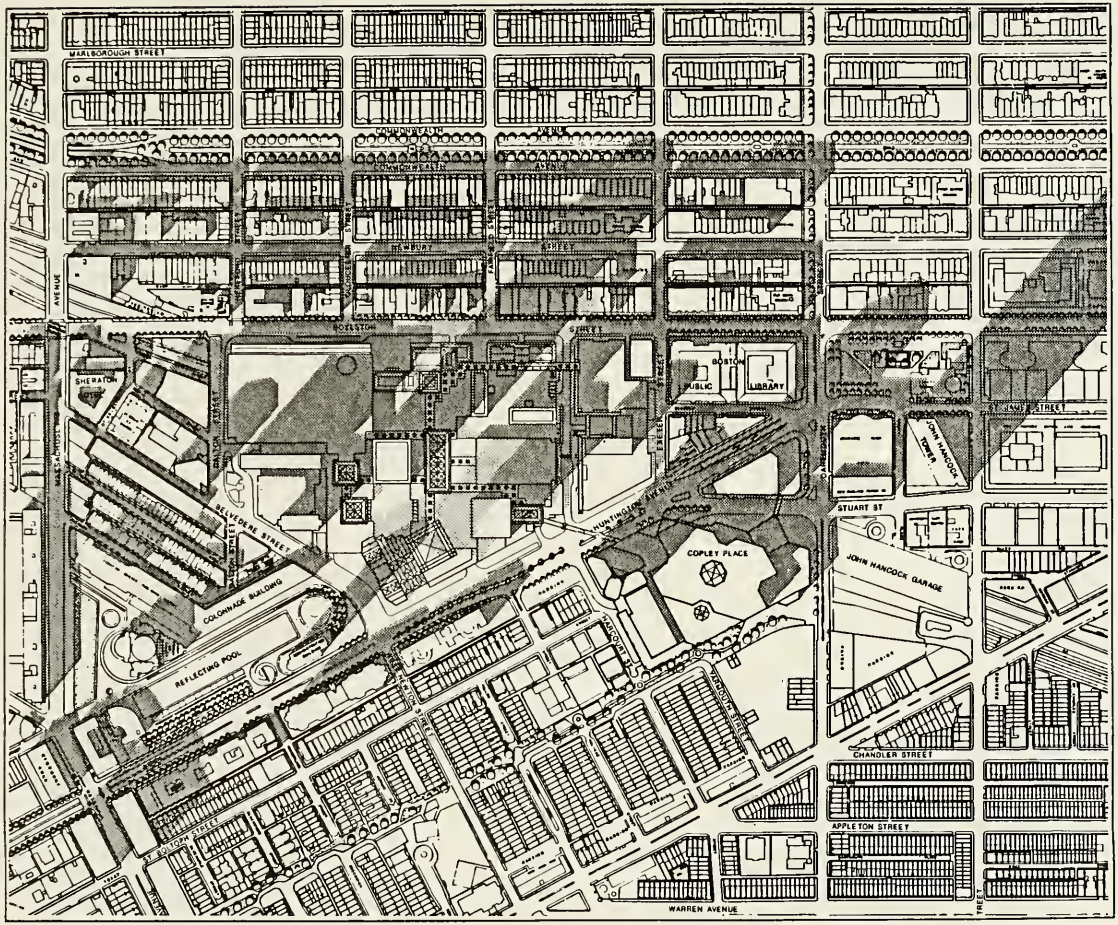
Fig. IVB-39
Horizontal Shadow Profile

Alternative A2
November 21
12:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

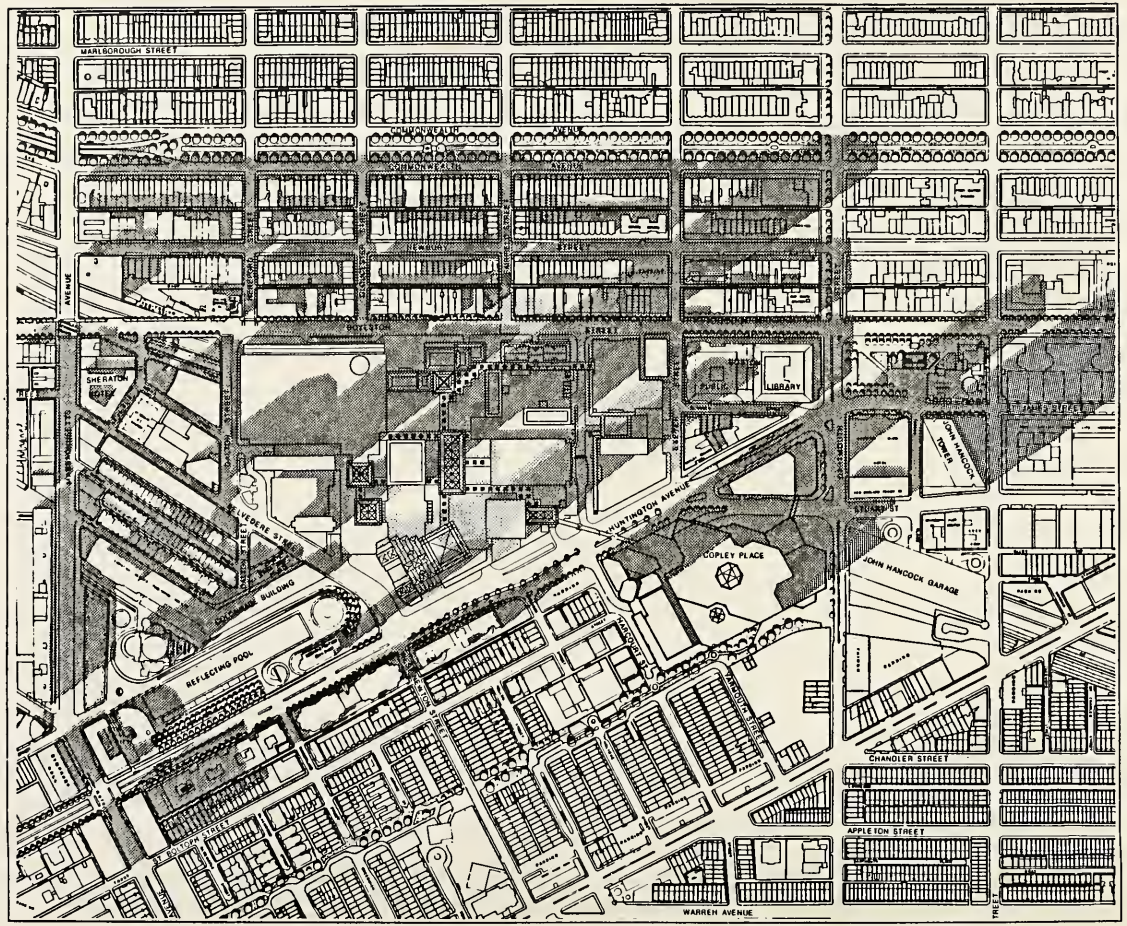
Fig. IVB-40
Horizontal Shadow Profile

Alternative A2
November 21
1:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

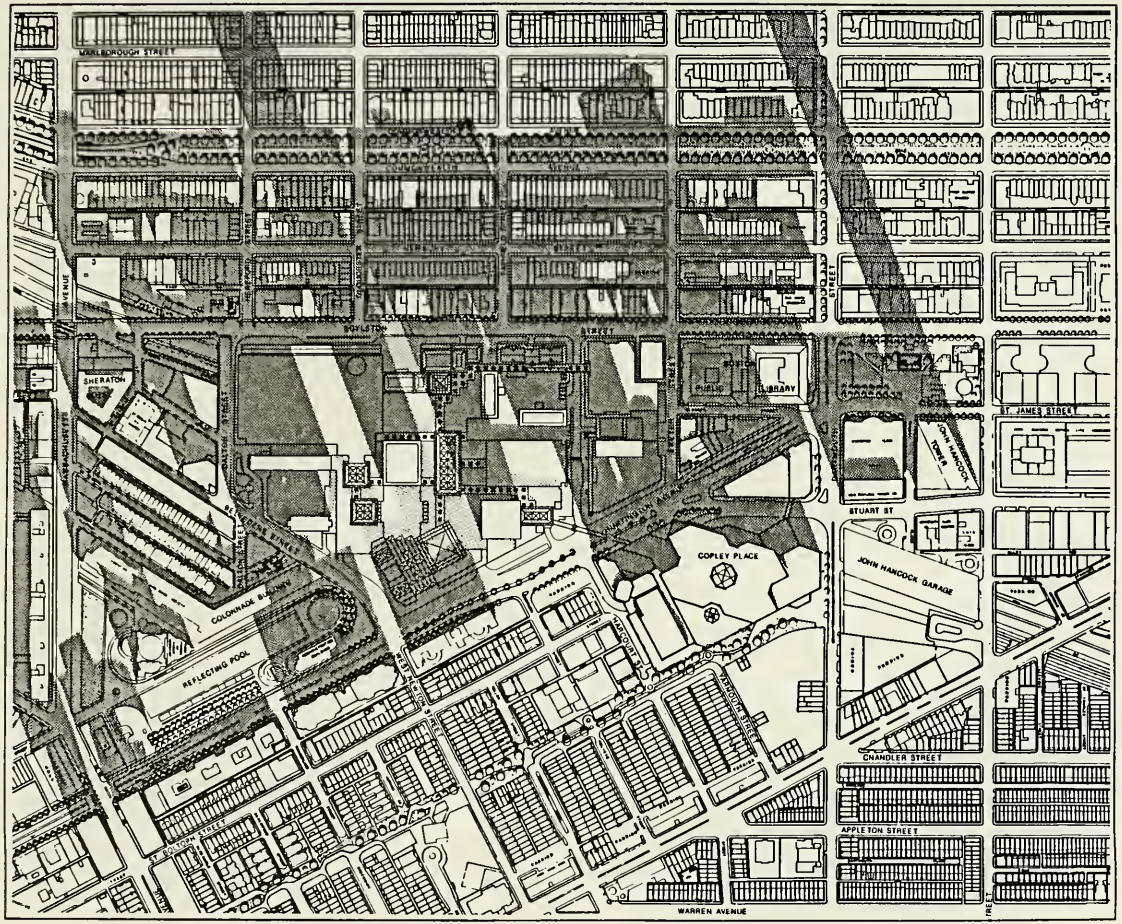
Fig. IVB-41
Horizontal Shadow Profile

Alternative A2
November 21
2:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

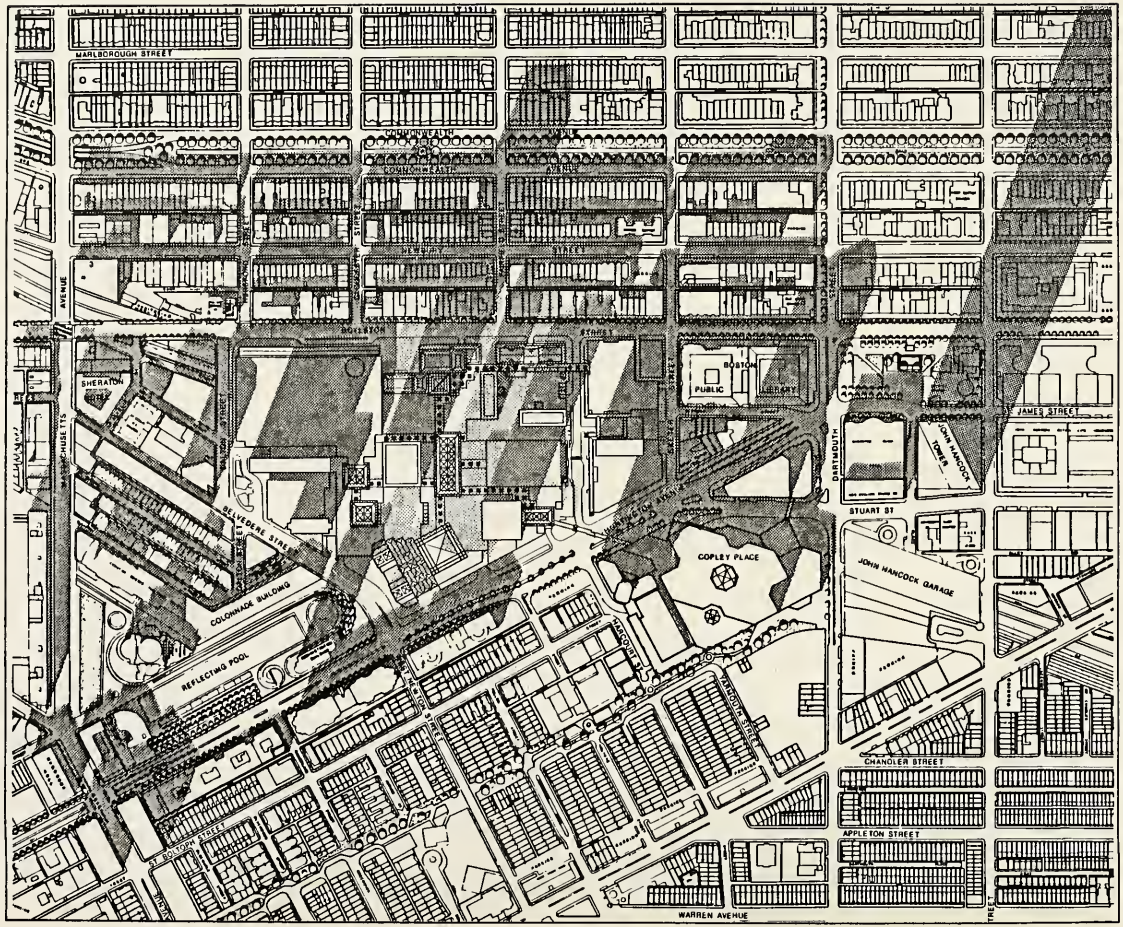
Fig. IVB-42
Horizontal Shadow Profile

Alternative A2
December 22
9:00 AM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

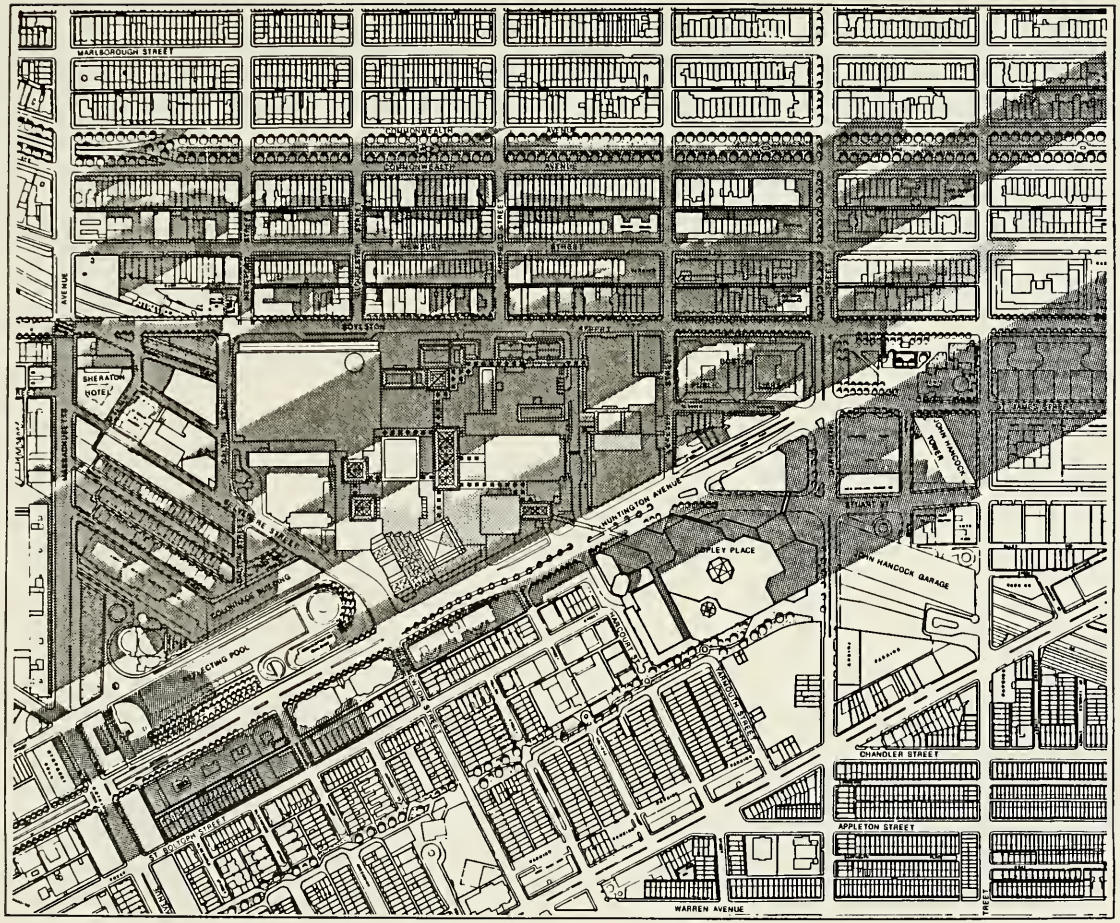
Fig. IVB-43
Horizontal Shadow Profile

Alternative A2
December 22
12:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

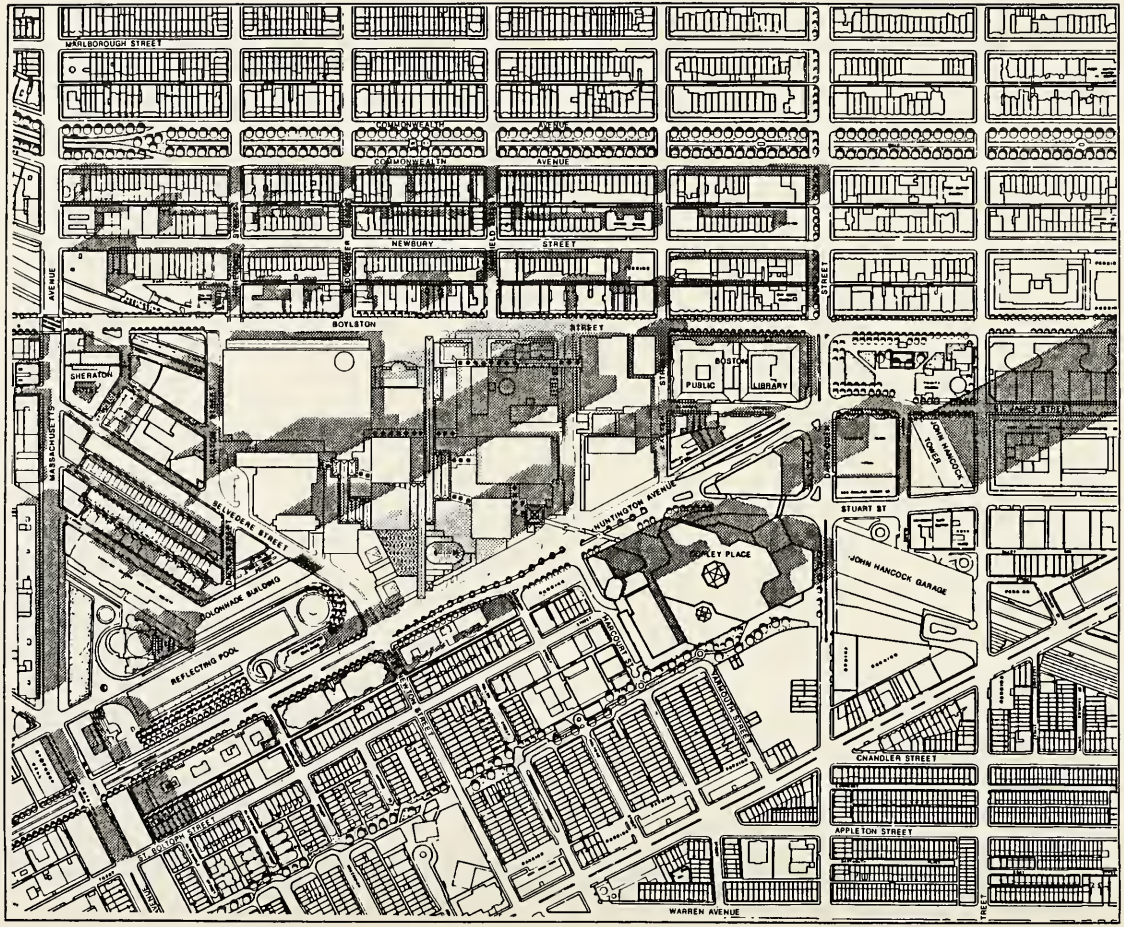
Fig. IVB-44
Horizontal Shadow Profile

Alternative A2
December 22
3:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale: Feet



Prudential Center Redevelopment

Fig. IVB-45
Horizontal Shadow Profile

Alternative B
March 21
2:00 PM EST

EXISTING SHADOW

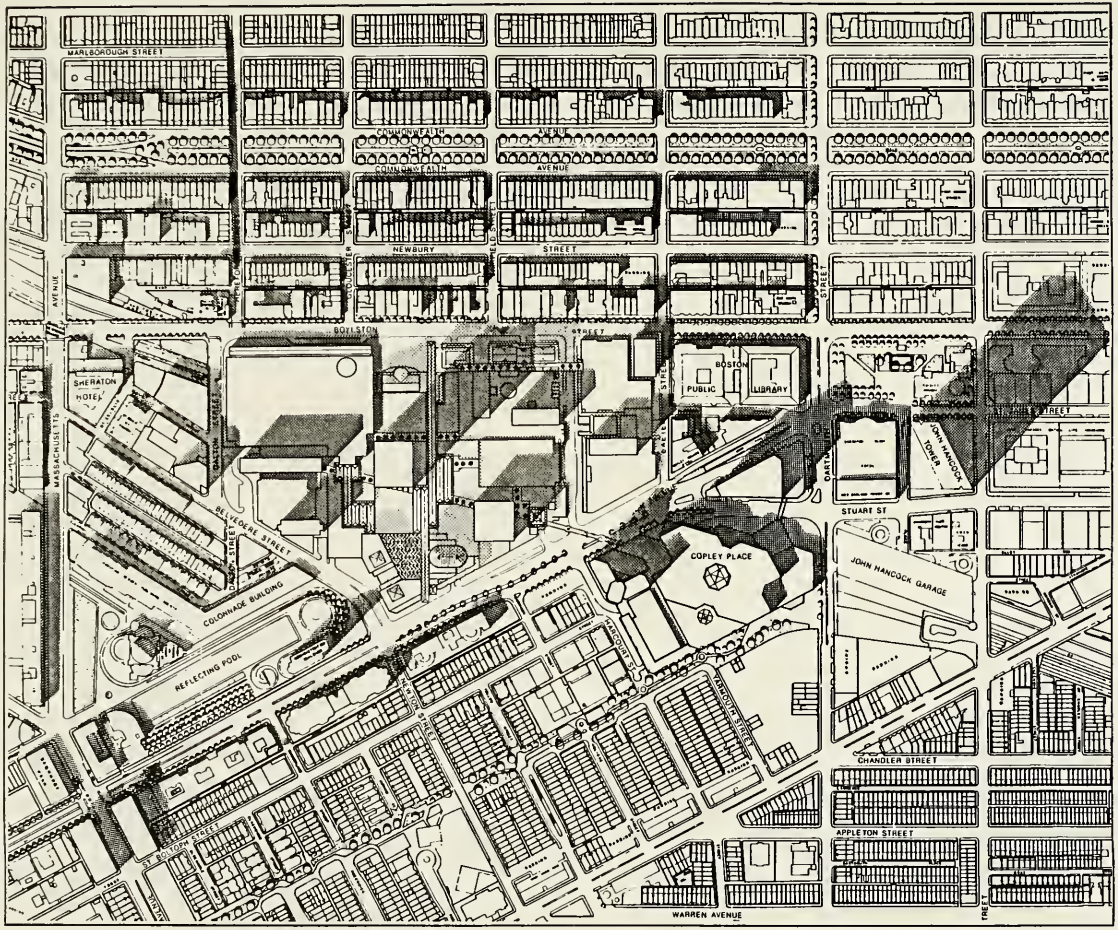
NET NEW SHADOW

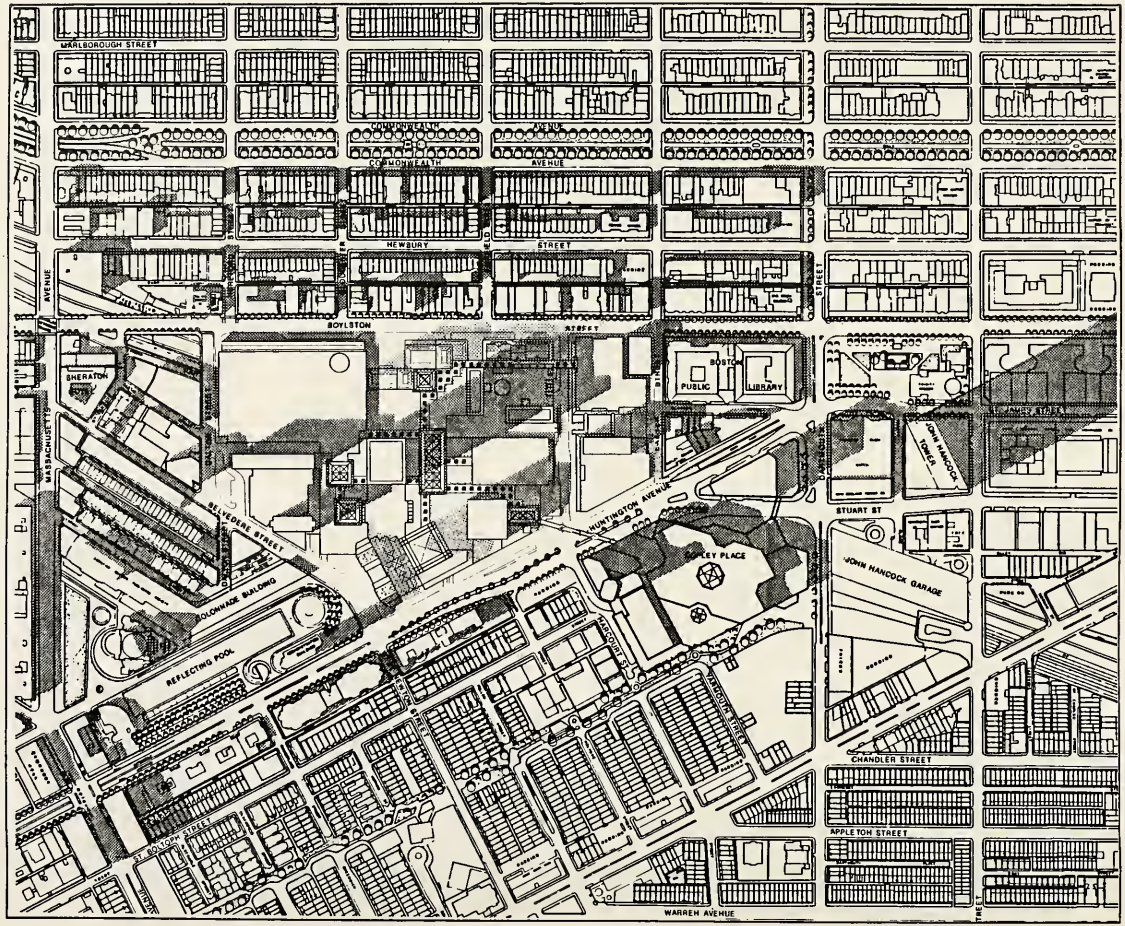
0 100 200
Scale: Feet

Prudential Center Redevelopment

Fig. IVB-46
Horizontal Shadow Profile

Alternative B
September 23
2:00 PM EDT





Prudential Center Redevelopment

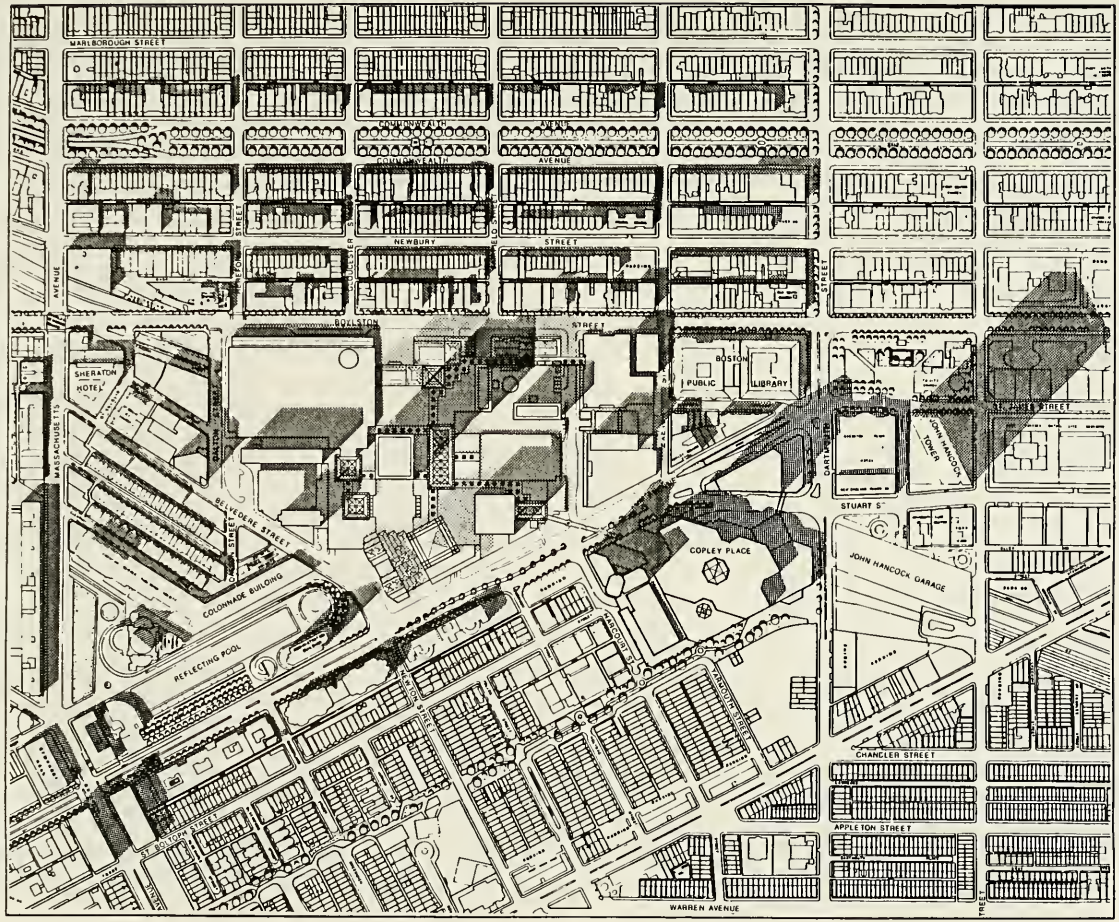
Fig. IVB-47
Horizontal Shadow Profile

Alternative B2
March 21
2:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

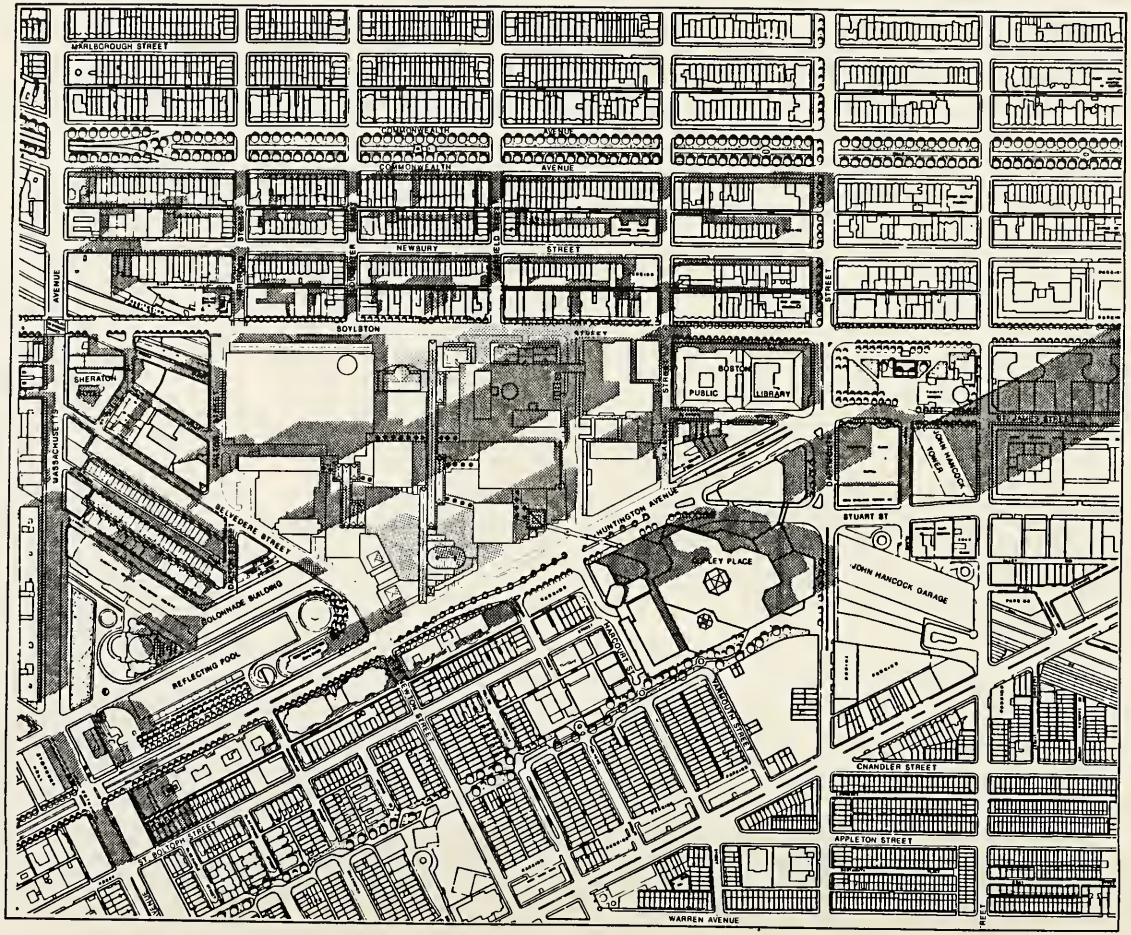
0 100 200
Scale : Feet



Prudential Center Redevelopment

Fig. IVB-48
Horizontal Shadow Profile

Alternative B2
September 23
2:00 PM EDT



Prudential Center Redevelopment

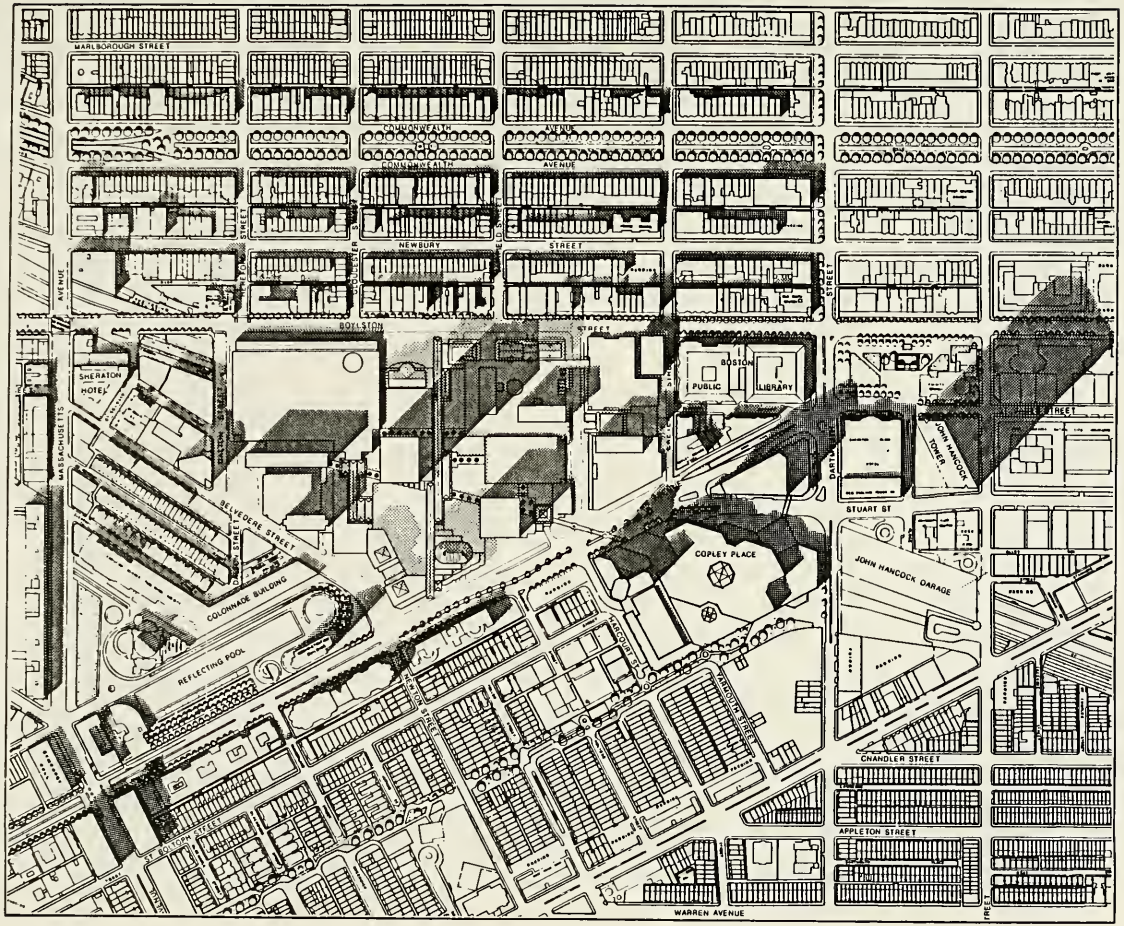
Fig. IVB-49
Horizontal Shadow Profile

Alternative C
March 21
2:00 PM EST

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet



Prudential Center Redevelopment

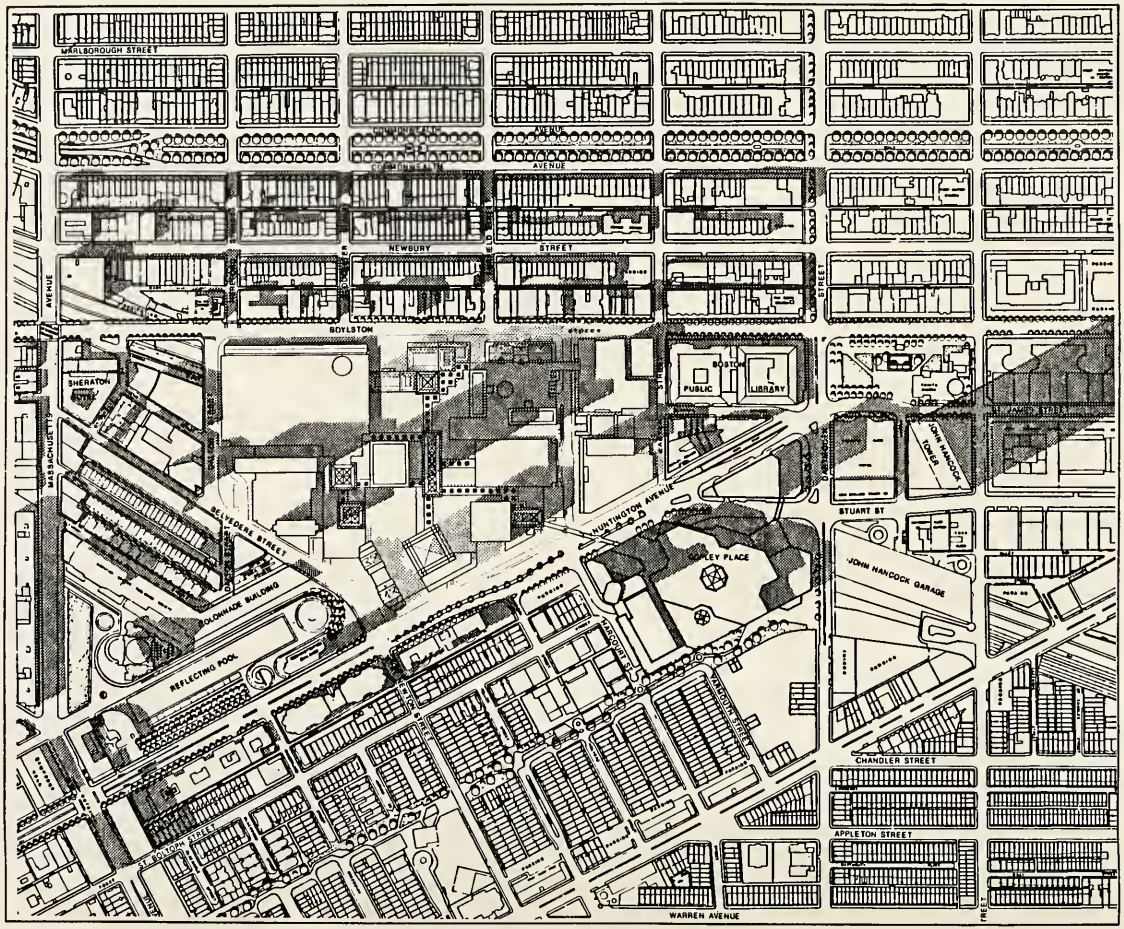
Fig. IVB-50
Horizontal Shadow Profile

Alternative C
September 23
2:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

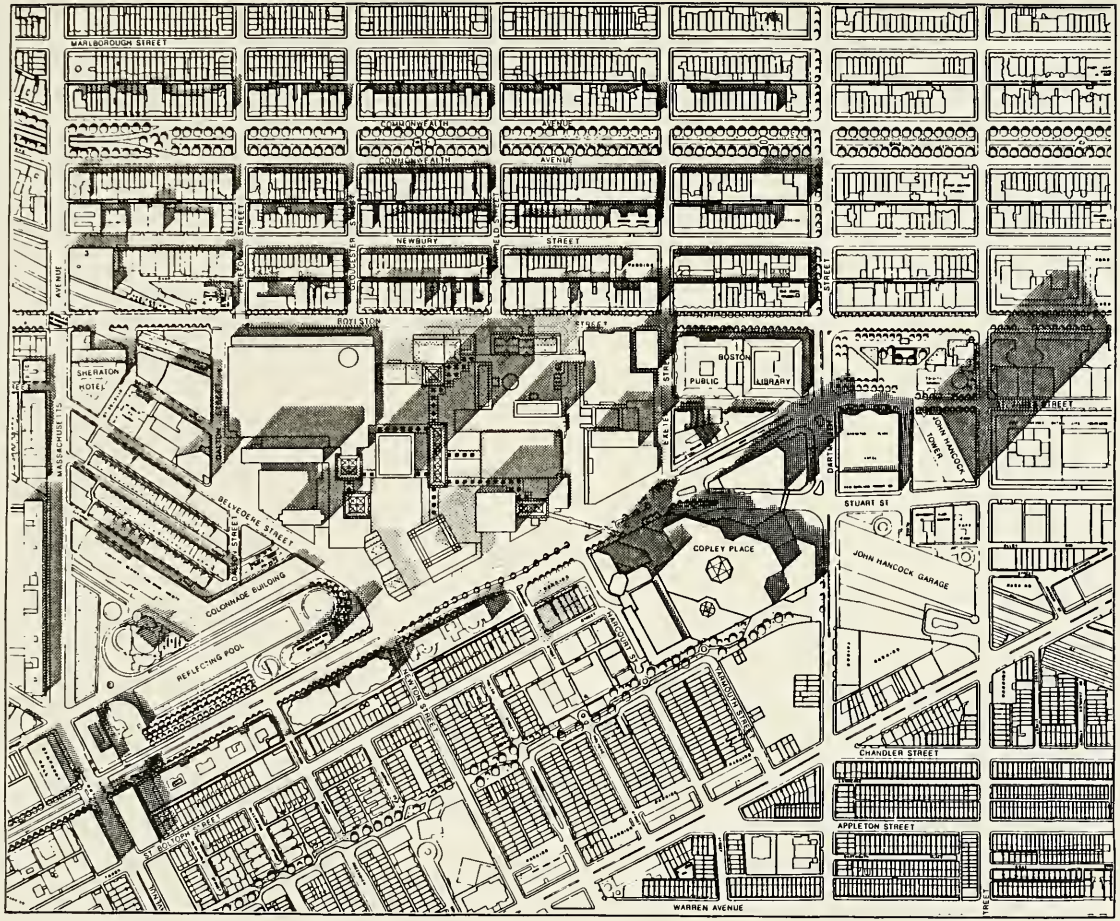
0 100 200
Scale: Feet



Prudential Center Redevelopment

Fig. IVB-51
Horizontal Shadow Profile

Alternative C2
March 21
2:00 PM EST



Prudential Center Redevelopment

Fig. IVB-52
Horizontal Shadow Profile

Alternative C2
September 23
2:00 PM EDT

EXISTING SHADOW

NET NEW SHADOW

0 100 200
Scale : Feet

APPENDIX B

Daylight studies were conducted for Alternatives B, B2, C, and C2 with the same viewpoints and technique described in Section 2.0 of this report. Table IVB–1 lists the percent daylight obstructed for each view and alternative. Figures IVB–1 through IVB–20 graphically depict the daylight obstruction for each alternative from Views 1 and 3. View 2 is not shown here since the daylight obstruction is the same for all alternatives (see Figure IV–9). The existing configuration for each view is shown in Section 2.0 of this report. Elevation views of each alternative are not included in this appendix, they are located in Volume II, Urban Design Alternatives.

TABLE IVB-1

PERCENT DAYLIGHT OBSTRUCTED FROM ALTERNATIVES B, B2, C, AND C2*

Roadway	View	DAYLIGHT OBSTRUCTED (%) Alternative B	Alternative B2	Alternative C	Alternative C2
Huntington Avenue	1	59.1	43.5	52.0	52.6
Huntington Avenue	2	30.6	30.6	30.6	30.6
Boylston Street	3	57.2	48.1	55.9	59.9
Overall Average		49.0	40.7	46.2	47.7

* The values do not include a reduction factor based on surface reflectance effects.

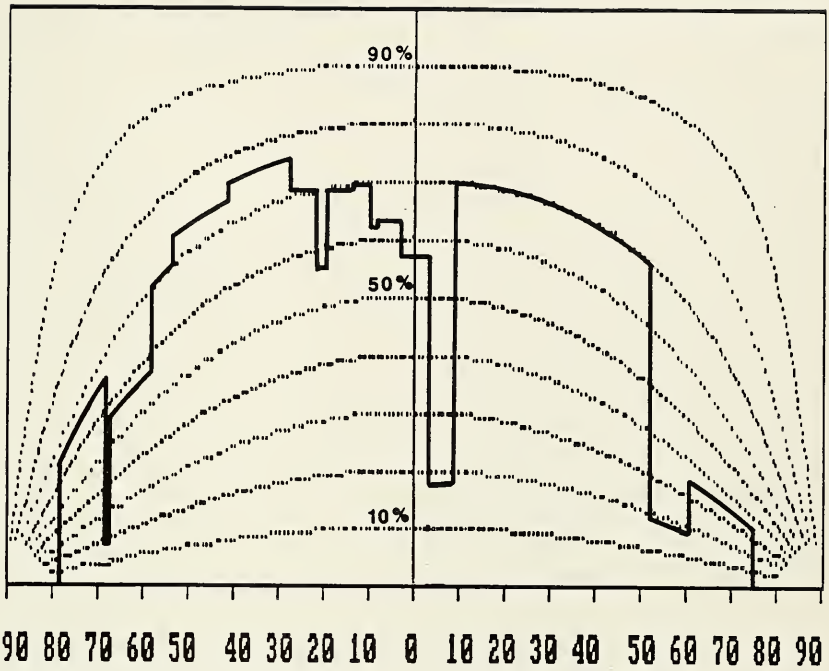


Fig. IVB-1
Huntington Avenue
View 1
Alternative B

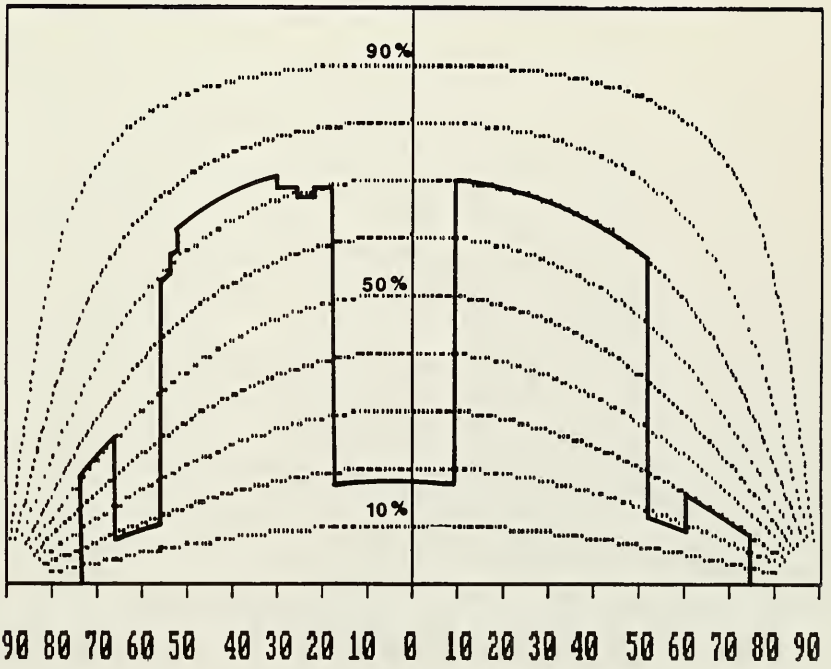


Fig. IVB-2
Huntington Avenue
View 1
Alternative B2

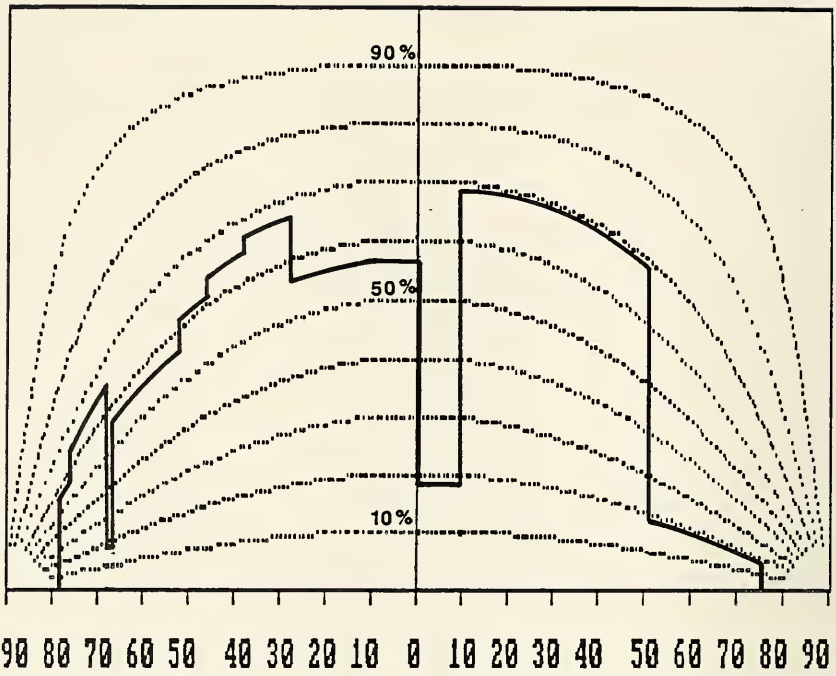


Fig. IVB-3
Huntington Avenue
View 1
Alternative C

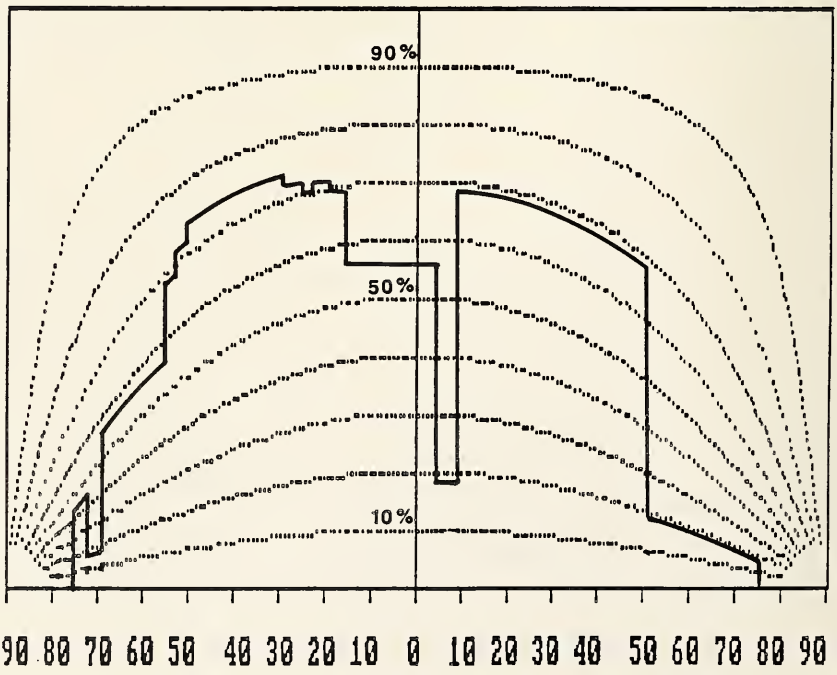


Fig. IVB-4
Huntington Avenue
View 1
Alternative C2

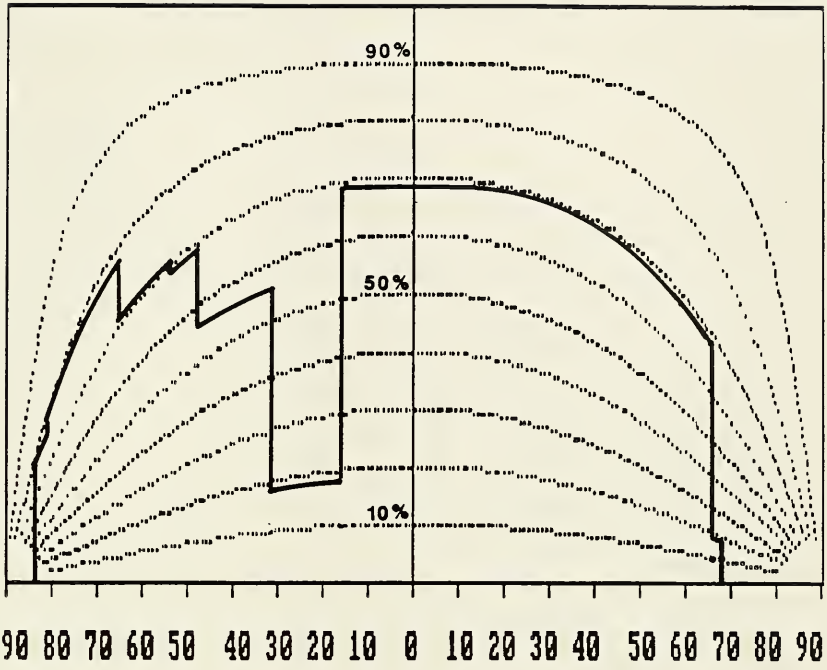


Fig. IVB-5
Boylston Street
View 3
Alternative B

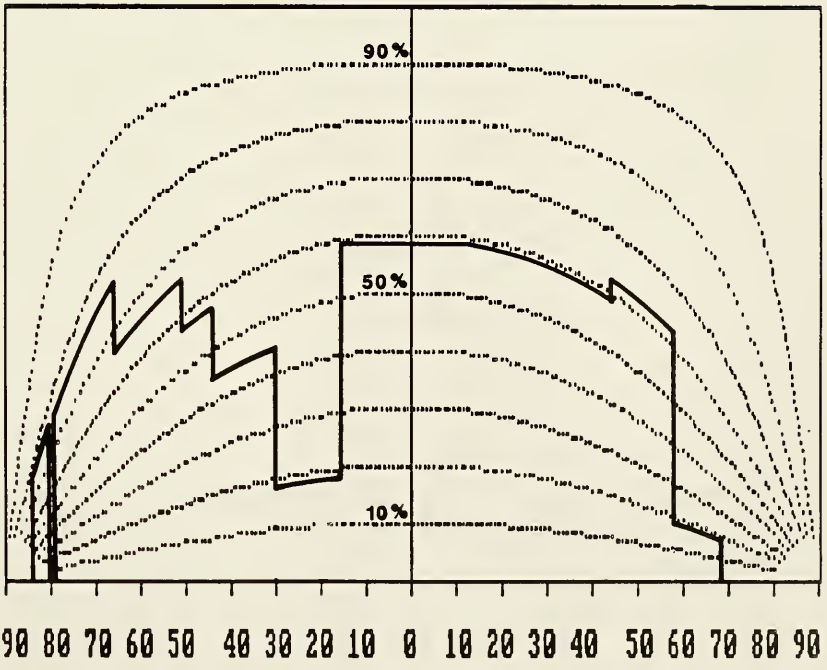


Fig. IVB-6
Boylston Street
View 3
Alternative B2

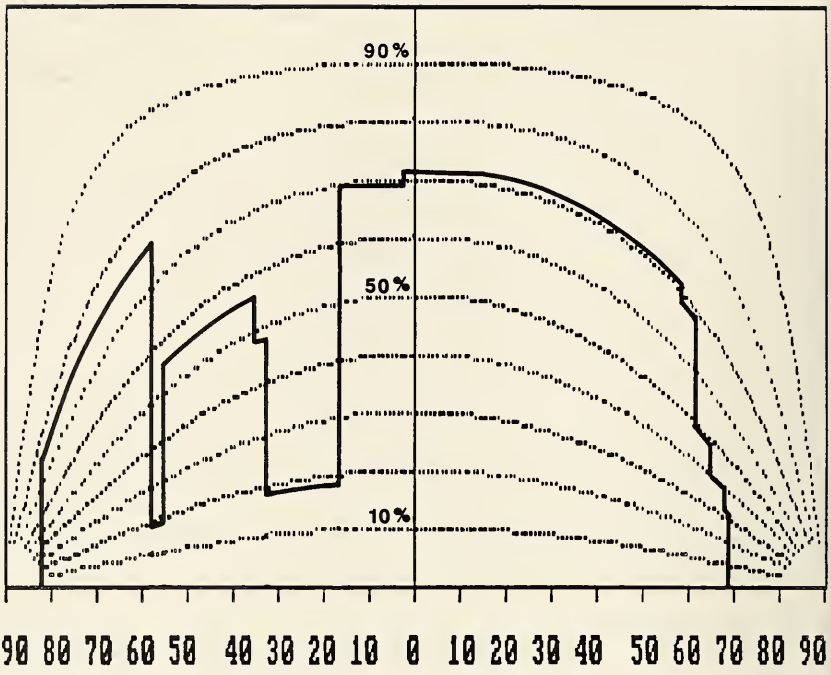


Fig. IVB-7
Boylston Street
View 3
Alternative C

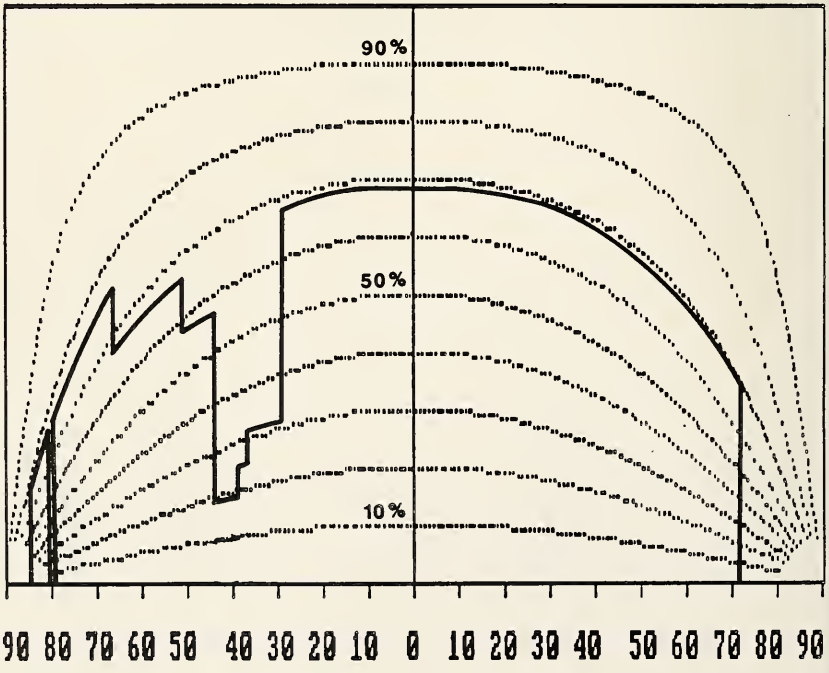


Fig. IVB-8
Boylston Street
View 3
Alternative C2

APPENDIX C

C.1 Motor Vehicle Emissions

Motor vehicle emissions used in this analysis were generated by the EPA MOBILE3 computer program*. Modeling runs were based on the MOBILE3 default national motor vehicle mix (see Table IVC-1) and an average December temperature of 30°F. The 1985 Massachusetts registration distribution for light duty vehicles, light duty trucks, and heavy duty trucks (see Table IVC-2) was used for the existing case, while the MOBILE3 default values were selected for all future cases. The MOBILE3 default national cold/hot start mix (presented in Table IVC-3) was used for determining roadway emissions during the peak eight-hour period. A mix with a higher cold start percentage for the rush hour was used to represent the peak one-hour period (see Table IVC-4). Emission rates are based on peak one-hour and eight-hour travel speeds for vehicles approaching each intersection as estimated from field surveys.

Table IVC-5 presents the composite free-flow emission rates for the peak one-hour and eight-hour periods. Idle mode emission rates for development of the CALQ3 linear queuing source strength were calculated based on a 5 mph vehicle speed and peak one- and eight-hour vehicle operating conditions as described above. These are shown in Table IVC-6. The MOBILE3 idle mode emission rates were not considered as they reflect only hot stabilized conditions.

The effect of the statewide inspection/maintenance (I/M) program was incorporated and included a program implemented in 1983, a 13% stringency level, no mechanic training, an earliest model year of 15 years prior to the analysis year, vehicle type categories of LDGV, LDGT1 and LDGT2, and an idle test with cut points of 1.2% and 220 ppm for CO and HC, respectively. In addition, no alternative I/M credits or anti-tampering program was assumed. The complete MOBILE3 output is found following Table IVC-9.

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* EPA, User's Guide to MOBILE3: Mobile Source Emissions Model, EPA-460/ 3-84-002, Ann Arbor, MI, June, 1984.

TABLE IVC-1
NATIONWIDE AVERAGE
MOTOR VEHICLE MIX BY TYPE*

VEHICLE TYPE	PERCENTAGE OF VMT		
	1988	1994	1999
Light-Duty Gasoline Vehicles (LDGV)	65.0	62.0	61.0
Light-Duty Gasoline Trucks			
0-6000 lb GVW** (LDGT1)	12.5	10.5	9.6
Over 6000 lb GVW (LDGT2)	9.0	8.6	8.7
Heavy-Duty Gasoline Trucks (HDGV)	3.5	4.1	4.1
Light-Duty Diesel Vehicles (LDDV)	3.6	6.4	7.5
Light-Duty Diesel Trucks (LDDT)	1.5	3.2	4.1
Heavy-Duty Diesel Trucks (HDDT)	4.2	4.6	4.4
Motorcycles (MC)	0.7	0.7	0.7
TOTAL***	100.0	100.1	100.1

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* EPA, User's Guide to MOBILE3: Mobile Source Emissions Model, EPA-460/3-84-002, Ann Arbor, MI, June, 1984.

** Gross vehicle weight.

*** Totals are greater than 100 percent due to rounding errors.

TABLE IVC-2
1985 MASSACHUSETTS VEHICLE
REGISTRATION DISTRIBUTION

VEHICLE AGE IN YEARS	PERCENT OF TOTAL VEHICLES		
	LDGV,LDDV	LDGT,LDDT	HDT (Gas & Diesel)
1	7.07	6.3	4.2
2	10.13	6.9	7.2
3	8.51	5.8	5.4
4	7.74	5.9	5.3
5	7.96	12.6	8.4
6	8.36	9.8	10.0
7	8.40	8.8	8.2
8	7.88	6.5	6.2
9	6.65	4.6	4.8
10	6.00	6.6	6.4
11	6.00	5.7	6.4
12	5.00	4.6	7.8
13	3.00	3.4	3.8
14	2.00	2.7	3.2
15	1.50	2.2	3.0
16	1.10	1.8	2.4
17	0.90	1.7	2.1
18	0.70	1.6	1.9
19	0.60	1.4	1.8
20 +	0.50	1.1	1.5
TOTAL	100.0	100.0	100.0

SOURCE: Massachusetts Department of Environmental Quality Engineering

TABLE IVC-3

NATIONWIDE AVERAGE

COLD/HOT START MIX FOR MOTOR VEHICLES

Vehicles Cold Start Mode	20.6%
Vehicles Hot Start Mode	27.3%
Vehicles Hot Stabilized Mode	52.1%
TOTAL	100.0%

TABLE IVC-4

RUSH HOUR COLD/HOT

START MIX FOR MOTOR VEHICLES

Vehicles Cold Start Mode	50.0%
Vehicles Hot Start Mode	10.0%
Vehicles Hot Stabilized Mode	40.0%
TOTAL	100.0%

TABLE IVC-5

COMPOSITE ONE- AND EIGHT-HOUR CO EMISSION RATES

Averaging Period	Roadway	Speed (mph)	CO Emission Rates (grams/mile) 1988	1994	1999
1-Hour	Dalton Street Hereford Street	14	83.16	55.20	48.19
	Parking Lot	15	78.84	52.61	46.02
	Columbus Avenue Belvidere Street West Newton Street	17	71.16	47.89	41.99
	Massachusetts Avenue Huntington Avenue Bolyston Street Exeter Street Stuart Street	18	67.72	45.72	40.12
	Massachusetts Turnpike	45	21.89	14.45	12.48
8-Hour	Parking Lot	15	50.02	33.30	29.24
	All Roadways	25	30.71	20.98	18.57
	Massachusetts Turnpike	50	12.80	7.96	6.69

TABLE IVC-6
IDLE MODE EMISSION RATES

Averaging Period	CO Emission Rate (grams/minute)		
	1988	1994	1999
1-Hour	13.28	7.62	6.19
8-Hour	8.52	4.88	3.98

C.2 CALQ3 Model

Approach

For each intersection studied and the Massachusetts Turnpike Extension, the EPA Regions I and IV CALQ3* computer program was used to predict CO concentrations at sensitive receptor locations. The CALQ3 program utilizes the FHWA CALINE3** computer model combined with a queuing routine to predict impacts from intersections. The CALQ3 intersection analysis involves superimposing motor vehicle idling emissions at queue links on free flow links. These modeling runs were supplemented by a set of assumptions consistent with DEQE requirements which include an ambient air temperature of 30°F, and worst case meteorological conditions of Pasquill-Gifford Class D stability combined with a 1.0 m/s wind speed for peak one-hour and eight-hour periods. Also, a winter mixing height of 900 meters*** was used. These meteorological data are appropriate for a December day during which peak CO concentrations are expected to occur. For each intersection, the full range of wind directions at 10 degree intervals was examined. In addition, a surface roughness (Z_o) of 321 cm (defined by CALINE3 for a central business district) and settling and deposition velocities of 0.0 cm/s were incorporated.

Traffic data input to the CALQ3 model included peak hour volumes for the one-hour averaging period. These data are provided in the Prudential Redevelopment Transportation Access Study (DPIR/EIR Volume III). Eight-hour average modeling runs were made using eight-hour volumes, calculated by multiplying an eight-hour to one-hour factor times the peak one-hour traffic data. Peak eight-hour to one-hour factors used were based on actual traffic counts. These are as follow:

- Massachusetts/Boylston: 0.85
- Massachusetts/Columbus: 0.83

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* EPA Region I, "CALQ3 Modeling Procedures," January 3, 1986.

** FHWA, CALINE3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets, FHWA/CA/TL-79/23, November, 1979.

*** Holzworth, G.C., Mixing Heights, Wind Speeds, and Potential for Urban Air Quality Throughout the Contiguous United States, USEPA, AP-101, January, 1972.

- o Columbus/West Newton: 0.81
- o Huntington/Belvidere/West Newton: 0.81
- o Huntington/Stuart/Exeter: 0.83
- o Boylston/Dalton/Hereford: 0.84

Intersection Analysis Results

Maximum predicted one- and eight-hour CO levels from CALQ3 modeling of key intersections in the project area are provided in Table IVC-7. Results shown in Table IVC-7 include background levels of 5.0 ppm and 3.0 ppm for the peak one- and eight-hour periods, respectively.

CALQ3 modeling output is lengthy and will be provided upon request.

C.3 Parking Garage and Tunnel Analysis

A separate analysis was performed to determine impacts associated with the Prudential Center Garage and Massachusetts Turnpike Tunnel under the Prudential Center and Copley Place. The analysis predicted maximum one-hour and eight-hour CO concentrations for the existing, future No-Build, and future Build cases. Concentrations from the garage and tunnel were calculated at all intersection receptor locations. Both garage and tunnel analyses used the EPA MOBILE3 and EPA Indirect Source Guidelines* in conjunction with Halitsky's gas diffusion equation to calculate CO concentrations at receptor sites.

The existing ventilation system design of the Prudential Center Garage includes forced air intakes. Air is exhausted out through garage entrance/exit openings. These entrance/exit openings were modeled as exhaust vents using Halitsky's gas diffusion equation.

Currently, the future design of the Prudential parking garage ventilation system has not been finalized. The garage under the redevelopment, however, will be serviced by forced air intake and exhaust ventilation units. Modeling is based on two exhaust vents, one for the north garage and one for the south garage, each located in the center of the

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* EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9 (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park, North Carolina, September 1978.

TABLE IVC-7

INTERSECTION IMPACTS PLUS BACKGROUND (ppm)

Intersection	Receptor Number	1988 Existing 1-Hr	1988 Existing 8-Hr	1994 No-Build 1-Hr	1994 No-Build 8-Hr	1994 Build 1-Hr	1994 Build 8-Hr	1994 Build With Mitigation 1-Hr	1994 Build With Mitigation 8-Hr	1999 No-Build 1-Hr	1999 No-Build 8-Hr	1999 Build 1-Hr	1999 Build 8-Hr	1999 Build With Mitigation 1-Hr	1999 Build With Mitigation 8-Hr
Boylston/ Massachusetts	1	16.7	8.4	13.2	6.7	13.3	6.7	13.3	6.7	12.7	6.5	13.0	6.5	13.0	6.5
	2	20.7	10.4	16.6	8.0	16.7	8.1	16.7	8.1	16.4	7.6	16.5	7.7	16.6	7.7
	3	16.7	9.2	13.3	6.9	13.3	6.9	13.3	6.9	12.5	6.6	12.6	6.6	12.6	6.6
	4	16.7	9.1	13.5	6.7	13.7	6.7	13.6	6.7	13.6	6.3	13.6	6.5	13.6	6.5
	5	19.1	9.3	16.2	7.5	16.2	7.8	16.2	7.8	16.2	7.4	16.2	7.6	16.2	7.6
Massachusetts/ Columbus	6	14.5	7.0	10.8	5.6	10.9	5.6	11.1	6.1	9.9	5.1	10.2	5.4	10.5	5.4
	7	15.2	7.4	12.0	6.1	12.1	6.3	11.9	6.3	10.7	5.6	11.1	5.8	11.3	5.9
	8	13.5	7.2	10.5	5.6	10.5	5.6	10.7	5.8	9.6	5.2	9.7	5.2	10.3	5.4
	9	15.1	8.6	11.5	6.3	11.6	6.6	11.3	6.3	10.6	5.8	10.7	6.0	10.6	5.9
	10	16.2	8.0	12.5	6.2	12.6	6.3	12.8	6.6	11.3	5.7	11.5	6.0	11.9	6.3
	11	22.2	11.0	16.1	8.3	16.3	8.4	15.8	8.0	14.3	7.5	14.9	7.6	14.2	7.2
Columbus/ W. Newton	12	11.4	5.9	9.6	4.9	9.7	4.9	9.6	4.9	9.0	4.6	9.0	4.6	9.0	4.6
	13	11.8	6.9	9.6	5.4	9.6	5.4	9.6	5.4	8.8	5.0	8.8	5.0	8.8	5.0
	14	13.6	7.7	10.6	5.7	10.7	5.9	10.6	5.8	9.7	5.4	9.9	5.5	9.8	5.4
	15	13.3	6.4	10.4	5.4	10.7	5.6	10.5	5.2	9.7	5.2	10.2	5.2	10.0	5.1
	16	10.9	5.5	8.6	4.5	8.9	4.6	8.8	4.4	8.2	4.5	8.4	4.6	8.3	4.4
Huntington/ Belvidere/ W. Newton	17	20.0	13.2	14.2	9.1	15.6	9.1	15.2	8.8	13.4	8.1	14.2	8.1	14.0	7.9
	18	14.3	7.9	11.1	6.0	12.3	6.7	12.0	6.3	10.3	5.6	11.2	6.1	10.7	5.8
	19	22.6	11.8	16.7	8.9	19.7	10.4	16.4	8.4	15.2	7.9	17.6	9.2	14.7	7.7
	20	17.3	9.4	13.0	7.1	14.7	8.0	13.4	7.2	11.8	6.5	13.3	7.3	12.0	6.5
	21	14.5	8.0	11.1	6.1	12.3	6.6	12.1	6.6	10.2	5.6	11.3	6.1	11.0	6.1
Huntington/ Stuart/ Exeter	22	18.2	10.5	13.5	7.4	13.6	7.6	13.1	7.3	12.1	6.9	12.3	6.9	11.9	6.6
	23	13.6	7.5	10.8	5.6	11.0	5.8	10.6	5.6	10.1	5.4	10.2	5.4	19.9	5.4
	24	16.7	9.5	12.3	6.8	12.4	6.9	11.9	6.3	11.0	6.2	11.2	6.3	11.1	6.0
	25	15.2	8.7	11.3	6.5	11.3	6.5	11.0	5.9	10.3	5.9	10.4	5.9	10.2	5.6
	26	18.3	10.4	13.4	7.4	13.4	7.6	13.4	7.4	12.0	6.8	12.1	6.8	12.1	6.8
Boylston/ Dalton/ Hereford	27	10.5	5.4	9.3	5.0	9.5	5.0	9.5	5.0	8.8	4.7	8.9	4.8	8.9	4.8
	28	13.4	6.8	11.6	6.1	12.1	6.3	11.9	6.1	10.8	5.6	11.1	5.9	11.1	5.9
	29	11.8	6.6	9.3	5.1	9.3	5.1	9.3	5.1	8.5	4.8	8.7	4.8	8.7	4.8
	30	11.6	5.8	11.3	5.6	12.1	6.2	12.1	5.6	10.3	5.1	11.1	5.6	11.1	5.6
	31	13.8	7.7	10.8	6.0	10.9	6.1	10.9	6.0	9.8	5.6	10.0	5.6	10.0	5.6

respective garages. The air will be vented on-site at the roof level of the new retail areas. The north garage vent was modeled having a total area of 34 square meters with a flow rate of 725,000 cfm. The south garage was modeled having a total area of 42 square meters with a flow rate of 865,000 cfm. These ventilation system characteristics will provide six air changes per hour in each garage.

Emissions of the parking garage were estimated using Worksheet 3 of the EPA Indirect Source Guidelines. These worksheets are included at the end of this Appendix.

The Turnpike Tunnel under the Prudential Center and Copley Place was modeled in four sections. The westbound section under the Prudential Center is ventilated with fans having a flow rate of 600,000 cfm. These fans are located at the eastern portion of this section and are directed westbound. Exhaust is emitted through the westbound exit portal which has an area of approximately 700 square feet.

The eastbound section of the tunnel under the Prudential Center has similar eastbound directed fans. Four exhaust fans at Copley Place exhaust the eastern section under the Prudential Center. Two additional exhaust fans service the eastbound and westbound sections of the tunnel under Copley Place. Each has a flow rate of 150,000 cfm. All six exhaust vents have a diameter of six feet and are located at Copley Place just east of the Huntington/Exeter/Stuart intersection.

Emissions for the tunnel were derived from the following formula:

$$\frac{\text{vehicles}}{\text{hour}} \times \text{miles} \times \frac{\text{grams CO}}{\text{veh. mi.}} \times \frac{\text{hour}}{3{,}600\text{s}} = \frac{\text{grams CO}}{\text{second}}$$

Volumes were based on 1989 Brighton-Allston toll booth records (January 9-13), with a five percent per year growth rate for future years, plus project-related traffic impact for Build cases. Table IVC-8 shows traffic and CO emissions for the tunnel.

The concentration of CO in the ventilation system exhaust was determined by the following formula:

$$X = 870\,(Q + (X_b)(F))/F$$

where:

X = CO concentration in the ventilation exhaust (ppm)

Q = CO emission rate for the vent system (g/s)

TABLE IVC-8

TURNPIKE TUNNEL TRAFFIC AND CO EMISSIONS (g/s)

CASE		Eastbound Vehicles	Westbound Vehicles	CO Emissions (g/s) Pru Section Westbound	Pru Section Eastbound	Copley Westbound	Copley Eastbound
1988	Existing						
	1-Hour	2,914	5,163	20.06	7.96	3.77	2.13
	8-Hour	2,351	3,381	6.03	3.76	1.44	1.00
1994	No-Build						
	1-Hour	3,905	6,919	18.52	7.04	3.33	1.88
	8-Hour	3,151	4,531	5.27	3.12	1.20	0.84
	Build						
	1-Hour	3,915	6,995	18.72	7.04	3.33	1.88
	8-Hour	3,159	4,578	5.32	3.12	1.20	0.84
1999	No-Build						
	1-Hour	4,984	8,830	20.91	7.76	3.67	2.07
	8-Hour	4,022	5,783	5.82	3.36	1.29	0.90
	Build						
	1-Hour	5,003	8,928	21.14	7.80	3.67	2.07
	8-Hour	4,037	5,844	5.88	3.36	1.29	0.90

X_b = Background concentration of CO in the makeup air assumed equal to background concentrations used in this analysis (g/m^3)

F = Volumetric flow rate (m^3/s)

Background concentrations of 5.0 ppm and 3.0 ppm were used for the 1-hour and 8-hour periods. These levels are equivalent to 5.75 (10^{-3}) and 3.45 (10^{-3}) g/m^3, respectively.

Ambient concentrations were scaled from the ventilation air levels using Halitsky's empirical model for gas diffusion near buildings. This model states that the ambient concentration X_a equals:

$$X_a = X/D$$

where D is a dilution factor defined as follows:

$$D = 2.22\,M\,(3.16 + 0.1(S)/(Ae)^{2}\,1/2*(V/Vc)$$

The terms are defined as follows:

M = Building configuration factor, equal to 4.0 for ground-level receptors in the cavity of the exhaust plume

S = Shortest arc distance from source to receptor (m)

Ae = Area of an exhaust opening

V = Ambient wind velocity (1.0 m/s)

Ve = Source exit velocity

Inputs for the Halitsky analysis were based on actual geometry and exhaust parameters for the garage and tunnels. Table IVC-9 shows the highest one- and eight-hour impacts from the garage and tunnel.

TABLE IVC-9

CO IMPACTS FROM TURNPIKE TUNNEL AND PRUDENTIAL GARAGE (ppm)

Intersection	Receptor Number	1988 Existing 1-Hr	1988 Existing 8-Hr	1994 No-Build 1-Hr	1994 No-Build 8-Hr	1994 Build 1-Hr	1994 Build 8-Hr	1999 No-Build 1-Hr	1999 No-Build 8-Hr	1999 Build 1-Hr	1999 Build 8-Hr
Boylston/ Massachusetts	1	1.7	0.7	1.5	0.6	1.8	0.7	1.6	0.6	2.1	0.8
	2	1.5	0.6	1.3	0.6	1.5	0.6	1.4	0.6	1.8	0.7
	3	1.5	0.6	1.4	0.6	1.6	0.7	1.5	0.6	1.9	0.7
	4	1.7	0.7	1.6	0.7	1.8	0.8	1.7	0.7	2.1	0.8
	5	2.0	0.8	1.8	0.7	2.1	0.9	1.9	0.8	2.4	0.9
Massachusetts/ Columbus	6	0.4	0.2	0.4	0.2	0.5	0.2	0.4	0.2	0.6	0.2
	7	0.4	0.2	0.4	0.2	0.5	0.2	0.4	0.2	0.6	0.2
	8	0.4	0.2	0.4	0.2	0.5	0.2	0.4	0.2	0.6	0.2
	9	0.4	0.2	0.4	0.2	0.5	0.2	0.4	0.2	0.6	0.2
	10	0.5	0.2	0.4	0.2	0.5	0.2	0.4	0.2	0.7	0.2
	11	0.4	0.2	0.4	0.2	0.5	0.2	0.4	0.2	0.6	0.2
Columbus/ W. Newton	12	0.9	0.4	0.9	0.4	1.0	0.4	0.9	0.4	1.2	0.5
	13	0.9	0.4	0.9	0.4	1.0	0.5	0.9	0.4	1.2	0.5
	14	0.9	0.4	0.8	0.4	1.0	0.4	0.9	0.4	1.2	0.5
	15	0.8	0.4	0.8	0.3	0.9	0.4	0.8	0.4	1.1	0.4
	16	0.8	0.4	0.7	0.3	0.8	0.4	0.7	0.3	1.0	0.4
Huntington/ Belvidere/ W. Newton	17	1.5	0.7	1.5	0.7	1.7	0.8	1.5	0.7	2.2	0.8
	18	1.9	0.9	1.8	0.8	2.0	0.9	1.8	0.8	2.5	0.9
	19	2.2	1.1	2.2	1.0	2.3	1.1	2.1	1.0	2.9	1.1
	20	2.1	1.0	2.1	1.0	2.2	1.0	2.0	0.9	2.8	1.0
	21	1.6	0.8	1.6	0.7	2.0	0.9	1.6	0.7	2.5	0.9
Huntington/ Stuart/ Exeter	22	4.7	2.2	4.2	1.9	4.2	1.9	4.6	2.0	4.6	2.0
	23	5.3	2.5	4.7	2.2	4.7	2.2	5.2	2.3	5.2	2.3
	24	6.5	3.1	5.9	2.7	5.9	2.7	6.4	2.8	6.4	2.8
	25	6.6	3.1	5.9	2.7	5.9	2.7	6.4	2.8	6.4	2.8
	26	7.8	3.7	7.1	3.2	7.1	3.2	7.7	3.4	7.7	3.4
Boylston/ Dalton/ Hereford	27	1.7	0.8	1.6	0.7	2.0	0.9	1.6	0.7	2.4	0.9
	28	1.9	0.8	1.7	0.7	2.1	0.9	1.8	0.7	2.5	0.9
	29	2.0	0.9	1.9	0.8	2.2	0.9	2.0	0.8	2.6	1.0
	30	1.9	0.8	1.7	0.7	2.1	0.9	1.8	0.8	2.6	0.9
	31	1.8	0.8	1.7	0.7	2.1	0.9	1.7	0.7	2.6	0.9

MOBILE3 EXISTING - INTERSECTION ANALYSIS 1988

I/M PROGRAM SELECTED:

START YEAR (JANUARY 1): 1983
PRE-1981 MYR STRINGENCY RATE: 13%
MECHANIC TRAINING PROGRAM?: NO
FIRST MODEL YEAR COVERED: 1973
LAST MODEL YEAR COVERED: 1988
VEHICLE TYPES COVERED: LDGV, LDGT1, LDGT2
1981 & LATER MYR TEST TYPE: IDLE
1981 & LATER MYR TEST CUTPOINTS: 1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	137.29	234.33	255.71	243.26	412.64	4.00	4.63	35.05	222.74	159.31

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	14.0	14.0	14.0		14.0	14.0	14.0	14.0	14.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	75.24	118.14	120.30	119.04	206.17	2.12	2.45	18.55	74.53	83.16

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	71.60	111.96	113.30	112.52	192.98	1.99	2.30	17.44	69.43	78.84

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	17.0	17.0	17.0		17.0	17.0	17.0	17.0	17.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	65.04	101.02	101.09	101.05	170.20	1.77	2.05	15.50	61.23	71.16

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	18.0	18.0	18.0		18.0	18.0	18.0	18.0	18.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	62.06	96.11	95.70	95.94	160.37	1.67	1.93	14.66	57.86	67.72

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	45.0	45.0	45.0		45.0	45.0	45.0	45.0	45.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	19.53	29.43	27.35	28.56	73.89	0.73	0.85	6.40	21.87	21.89

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	81.95	141.43	157.90	147.93	412.64	3.48	4.06	35.05	135.20	102.21

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

AL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

EH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
EH. SPD.:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	

OMPOSITE EMISSION FACTORS (GM/MILE)

XHST CO:	42.37	67.12	68.63	67.75	192.98	1.73	2.02	17.44	42.14	50.02

SER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

AL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

EH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
EH. SPD.:	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	

OMPOSITE EMISSION FACTORS (GM/MILE)

XHST CO:	33.48	52.28	52.11	52.21	143.32	1.31	1.52	13.17	31.66	38.88

SER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

AL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

EH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
EH. SPD.:	50.0	50.0	50.0		50.0	50.0	50.0	50.0	50.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	

OMPOSITE EMISSION FACTORS (GM/MILE)

XHST CO:	9.98	15.69	14.25	15.09	76.33	0.63	0.74	6.35	12.29	12.80

MOBILE3 EXISTING - INTERSECTION ANALYSIS 1988

I/M PROGRAM SELECTED:

START YEAR (JANUARY 1):	1983
PRE-1981 MYR STRINGENCY RATE:	13%
MECHANIC TRAINING PROGRAM?:	NO
FIRST MODEL YEAR COVERED:	1973
LAST MODEL YEAR COVERED:	1988
VEHICLE TYPES COVERED:	LDGV, LDGT1, LDGT2
1981 & LATER MYR TEST TYPE:	IDLE
1981 & LATER MYR TEST CUTPOINTS:	1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

USER SUPPLIED VEH REGISTRATION DISTRIBUTIONS.

CAL. YEAR: 1988 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	25.0	25.0	25.0		25.0	25.0	25.0	25.0	25.0	
VMT MIX:	0.650	0.125	0.090		0.035	0.036	0.015	0.042	0.007	

COMPOSITE EMISSION FACTORS (GM/MILE)

EXHST CO:	26.64	41.09	40.43	40.81	112.46	1.03	1.21	10.41	25.25	30.71

MOBILE3 1994 - INTERSECTION ANALYSIS

I/M PROGRAM SELECTED:

START YEAR (JANUARY 1): 1983
PRE-1981 MYR STRINGENCY RATE: 13%
MECHANIC TRAINING PROGRAM? NO
FIRST MODEL YEAR COVERED: 1979
LAST MODEL YEAR COVERED: 1994
VEHICLE TYPES COVERED: LDGV, LDGT1, LDGT2
1981 & LATER MYR TEST TYPE: IDLE
1981 & LATER MYR TEST CUTPOINTS: 1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	87.42	142.09	154.64	147.73	144.16	4.03	4.62	27.46	221.75	91.46

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	14.0	14.0	14.0		14.0	14.0	14.0	14.0	14.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	56.50	82.53	83.81	83.10	72.03	2.13	2.44	14.53	74.27	55.20

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	54.03	78.67	79.51	79.05	67.42	2.01	2.30	13.66	69.19	52.61

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	17.0	17.0	17.0		17.0	17.0	17.0	17.0	17.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	49.42	71.64	71.80	71.71	59.46	1.78	2.04	12.15	61.03	47.89

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	18.0	18.0	18.0		18.0	18.0	18.0	18.0	18.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	47.27	68.42	68.31	68.37	56.03	1.69	1.93	11.48	57.68	45.72

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	45.0	45.0	45.0		45.0	45.0	45.0	45.0	45.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	14.53	21.10	20.04	20.63	25.82	0.74	0.84	5.02	21.79	14.45

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	52.45	88.20	98.03	92.62	144.16	3.49	4.05	27.46	134.64	58.61

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	32.35	48.81	49.95	49.32	67.42	1.74	2.01	13.66	42.01	33.30

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT.

I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 29.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	24.65	32.20	32.42	32.31	36.53	1.33	1.55	9.93	31.58	23.24

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	50.0	50.0	50.0		50.0	50.0	50.0	50.0	50.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	6.62	8.10	8.16	8.13	19.45	0.64	0.75	4.79	12.26	6.69

MOBILE3 1994 - INTERSECTION ANALYSIS

I/M PROGRAM SELECTED:

START YEAR (JANUARY 1):	1983
PRE-1981 MYR STRINGENCY RATE:	13%
MECHANIC TRAINING PROGRAM?:	NO
FIRST MODEL YEAR COVERED:	1979
LAST MODEL YEAR COVERED:	1994
VEHICLE TYPES COVERED:	LDGV, LDGT1, LDGT2
1981 & LATER MYR TEST TYPE:	IDLE
1981 & LATER MYR TEST CUTPOINTS:	1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

CAL. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	25.0	25.0	25.0		25.0	25.0	25.0	25.0	25.0	
VMT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	20.76	30.82	30.65	30.74	39.29	1.04	1.20	8.16	25.18	20.98

I/M PROGRAM SELECTED:

START YEAR (JANUARY 1): 1983
PRE-1981 MYR STRINGENCY RATE: 13%
MECHANIC TRAINING PROGRAM?: NO
FIRST MODEL YEAR COVERED: 1984
LAST MODEL YEAR COVERED: 1999
VEHICLE TYPES COVERED: LDGV, LDGT1, LDGT2
1981 & LATER MYR TEST TYPE: IDLE
1981 & LATER MYR TEST CUTPOINTS: 1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	78.96	101.77	102.17	101.96	105.17	4.11	4.72	26.43	221.75	74.29

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	14.0	14.0	14.0		14.0	14.0	14.0	14.0	14.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	53.23	66.68	66.98	66.82	52.54	2.18	2.50	13.98	74.27	48.19

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	50.95	63.63	63.92	63.77	49.18	2.05	2.35	13.15	69.19	46.02

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	17.0	17.0	17.0		17.0	17.0	17.0	17.0	17.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	46.68	57.95	58.22	58.08	43.38	1.82	2.09	11.69	61.03	41.99

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	18.0	18.0	18.0		18.0	18.0	18.0	18.0	18.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	44.68	55.31	55.57	55.43	40.87	1.72	1.97	11.05	57.68	40.12

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 50.0 / 10.0 / 50.0

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	45.0	45.0	45.0		45.0	45.0	45.0	45.0	45.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	13.69	15.88	15.97	15.92	18.83	0.75	0.86	4.83	21.79	12.48

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	47.55	64.91	65.28	65.08	105.17	3.55	4.14	26.43	134.64	47.72

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	15.0	15.0	15.0		15.0	15.0	15.0	15.0	15.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	30.68	40.64	40.90	40.77	49.18	1.77	2.06	13.15	42.01	29.24

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT

I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

I. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
I SPD.:	20.0	20.0	20.0		20.0	20.0	20.0	20.0	20.0	
MT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	

POSITE EMISSION FACTORS (GM/MILE)

ST	CO:	25.91	38.76	38.91	38.83	50.07	1.31	1.52	10.32	31.58	26.33

. YEAR: 1994 REGION: LOW ALTITUDE: 500. FT
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
SPD.:	50.0	50.0	50.0		50.0	50.0	50.0	50.0	50.0	
MT MIX:	0.620	0.105	0.086		0.041	0.064	0.032	0.046	0.007	

POSITE EMISSION FACTORS (GM/MILE)

ST	CO:	7.12	11.21	10.53	10.91	26.67	0.63	0.73	4.98	12.26	7.96

MOBILE3 1999 - INTERSECTION ANALYSIS

I/M PROGRAM SELECTED:

START YEAR (JANUARY 1):	1983
PRE-1981 MYR STRINGENCY RATE:	13%
MECHANIC TRAINING PROGRAM?:	NO
FIRST MODEL YEAR COVERED:	1984
LAST MODEL YEAR COVERED:	1999
VEHICLE TYPES COVERED:	LDGV, LDGT1, LDGT2
1981 & LATER MYR TEST TYPE:	IDLE
1981 & LATER MYR TEST CUTPOINTS:	1.2% ICO / 220 PPM IHC

TOTAL HC EMISSION FACTORS INCLUDE EVAPORATIVE HC EMISSION FACTORS.

CAL. YEAR: 1999 REGION: LOW ALTITUDE: 500. FT.
I/M PROGRAM: YES AMBIENT TEMP: 30.0 (F)
ANTI-TAM. PROGRAM: NO OPERATING MODE: 20.6 / 27.3 / 20.6

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	25.0	25.0	25.0		25.0	25.0	25.0	25.0	25.0	
VMT MIX:	0.610	0.096	0.087		0.041	0.075	0.041	0.044	0.007	
COMPOSITE EMISSION FACTORS (GM/MILE)										
EXHST CO:	19.80	25.54	25.71	25.62	28.66	1.05	1.23	7.85	25.18	18.57

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # EXISTING Year 1988 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1 (IN)	2 (OUT)	3 (IN/OUT)	4 (IN/OUT)
1	Brt	Base running time				
1.1		Base approach time(s)		10	10	10
1.2		Base entrance time(s)		10	10	10
1.3		Base movement-in time(s)		60	36	27
1.4		Base stop, base start time(s)	10	10	10	10
1.5		Base movement-out time(s)	60		36	27
1.6		Base exit time(s)	30		30	30
1.7		Base departure time(s)	10		10	10
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)	49368 m^2			
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		20	10	65
5	Ce_i	Entrance approach capacities (vph)		749	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	105		50	110
8	Cx_i	Exit approach capacities (vph)	739		704	537
9		Number of parking spaces occupied				
10	F	Emissions	78.84 g/mi			
11	Pc	Capacity of parking lot (veh)	2506			
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio		0.03	0.01	0.07
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio	0.14		0.07	0.20
14.3	Re_i	Excess running time entering parking lot		0.13	0.04	0.25
14.4	Rx_i	Excess running time exiting parking lot	0.81		0.39	1.73
15	Te_i	Total entering running time (s/veh)		90.13	71.04	62.25
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	110.81		71.39	63.73
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.63			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # EXISTING Year 1988 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1 (OUT)	2 (IN)	3 (IN/O)	4 (IN/OUT)
1	Brt	Base running time				
1.1		Base approach time(s)		10	10	10
1.2		Base entrance time(s)		10	10	10
1.3		Base movement-in time(s)		60	36	27
1.4		Base stop, base start time(s)	10	10	10	10
1.5		Base movement-out time(s)	60		36	27
1.6		Base exit time(s)	30		30	30
1.7		Base departure time(s)	10		10	10
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)	49368 m^2			
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		17	7	58
5	Ce_i	Entrance approach capacities (vph)		758	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	90		43	95
8	Cx_i	Exit approach capacities (vph)	747		704	589
9		Number of parking spaces occupied				
10	F	Emissions	50.02 g/mi			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.11	0.03	0.21
14.4	Rx_i	Excess running time exiting parking lot	0.66		0.23	1.27
15	Te_i	Total entering running time (s/veh)		90.11	71.03	62.21
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	110.66		71.23	63.27
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	1.42 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # NO BUILD Year 1994 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1 (OUT)	2 (IN)	3 (IN/O)	4 (IN/OUT)
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)	49368 m^2			
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		23	10	69
5	Ce_i	Entrance approach capacities (vph)		724	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	157		118	195
8	Cx_i	Exit approach capacities (vph)	738		681	505
9		Number of parking spaces occupied				
10	F	Emissions	52.61 g/mi			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.16	0.04	0.27
14.4	Rx_i	Excess running time exiting parking lot	1.32		1.11	4.48
15	Te_i	Total entering running time (s/veh)		90.16	71.04	62.27
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	111.32		72.11	66.48
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.80 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # No BUILD Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream 1 (OUT)	2 (IN)	3 (IN/OUT)	4 (IN/O)
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)	49368 m^2			
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume (vph)		20	7	59
5	Ce_i	Entrance approach capacities (vph)		734	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	135		102	168
8	Cx_i	Exit approach capacities (vph)	746		697	540
9		Number of parking spaces occupied				
10	F	Emissions	33.30			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.14	0.03	0.23
14.4	Rx_i	Excess running time exiting parking lot	1.07		0.89	3.01
15	Te_i	Total entering running time (s/veh)		90.14	71.03	62.23
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	111.07		71.89	65.23
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	1.51 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # BUILD Year 1994 Averaging Time 1 HOUR

Step	Symbol	Input/Units	Traffic Stream			
1	Brt	Base running time	1(OUT)	2 (IN)	3 (IN/O)	4 (IN/OUT)
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		30	10	77
5	Ce_i	Entrance approach capacities (vph)		678	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	257		132	262
8	Cx_i	Exit approach capacities (vph)	734		637	505
9		Number of parking spaces occupied				
10	F	Emissions	52.61	g/mi		
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.25	0.04	0.30
14.4	Rx_i	Excess running time exiting parking lot	2.64		1.48	7.69
15	Te_i	Total entering running time (s/veh)		90.25	71.04	62.30
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	112.64		72.48	69.69
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	3.96 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # BUILD Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1(OUT)	2(IN)	3(IN/O)	4(IN/O)
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		26	7	66
5	Ce_i	Entrance approach capacities (vph)		695	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	221		114	225
8	Cx_i	Exit approach capacities (vph)	743		643	505
9		Number of parking spaces occupied				
10	F	Emissions	33.30			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.20	0.03	0.25
14.4	Rx_i	Excess running time exiting parking lot	2.05		1.21	2.89
15	Te_i	Total entering running time (s/veh)		90.20	71.03	62.25
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	112.05		72.21	64.89
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.10 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. 1				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # No Build Year 1999 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1(OUT)	2(IN)	3(IN/O)	4(IN/O)
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		23	10	69
5	Ce_i	Entrance approach capacities (vph)		724	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	157		118	195
8	Cx_i	Exit approach capacities (vph)	738		681	497
9		Number of parking spaces occupied				
10	F	Emissions	46.02			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.16	0.04	0.27
14.4	Rx_i	Excess running time exiting parking lot	1.32		1.11	4.63
15	Te_i	Total entering running time (s/veh)		90.16	71.04	62.27
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	111.32		72.11	66.63
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.45 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. 1				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # No BUILD Year 1999 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1(OUT)	2(IN)	3(IN/O)	4(IN/O)
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	110	90	142	124
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		20	7	59
5	Ce_i	Entrance approach capacities (vph)		734	1000	1000
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	135		102	168
8	Cx_i	Exit approach capacities (vph)	746		697	535
9		Number of parking spaces occupied				
10	F	Emissions	29.24			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.14	0.03	0 23
14.4	Rx_i	Excess running time exiting parking lot	1.07		0.89	3.08
15	Te_i	Total entering running time (s/veh)		90.14	71.03	62.23
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	111.07		71.89	65.08
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	1.33 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE
Case # BUILD Year 1997 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream 1 (IN)	1 (OUT)	2 (IN)	2 (OUT)
1	Brt	Base running time	150		124	
1.1		Base approach time(s)	10		10	
1.2		Base entrance time(s)	10		10	
1.3		Base movement-in time(s)	45		27	
1.4		Base stop, base start time(s)	10		10	
1.5		Base movement-out time(s)	45		27	
1.6		Base exit time(s)	30		30	
1.7		Base departure time(s)	0		10	
1.8		Total base running time(s)				
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)	45		69	
5	Ce_i	Entrance approach capacities (vph)	1000		1000	
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)		424		195
8	Cx_i	Exit approach capacities (vph)		387		499
9		Number of parking spaces occupied				
10	F	Emissions	46.02			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot	0.17		0.27	
14.4	Rx_i	Excess running time exiting parking lot		358		4.63
15	Te_i	Total entering running time (s/veh)	75.17		62.27	
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)		433		66.63
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	10.88 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source NORTH GARAGE

Case # BUILD Year 1999 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	Brt	Base running time	1		2	
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	150		124	
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)	39		59	
5	Ce_i	Entrance approach capacities (vph)	1000		1000	
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)		365		168
8	Cx_i	Exit approach capacities (vph)		432		535
9		Number of parking spaces occupied				
10	F	Emissions	29.24			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot	0.15		0.23	
14.4	Rx_i	Excess running time exiting parking lot		45.4		3.08
15	Te_i	Total entering running time (s/veh)	75.15		62.23	
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)		120.4		65.08
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.09 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE
Case # EXISTING Year 1988 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1(OUT)	2(IN/O)	3(IN/O)	4(IN/O)
1	Brt	Base running time				
1.1		Base approach time(s)		10	10	10
1.2		Base entrance time(s)		41	48	50
1.3		Base movement-in time(s)		10	10	10
1.4		Base stop, base start time(s)	10	10	10	10
1.5		Base movement-out time(s)	16	41	48	50
1.6		Base exit time(s)	30	30	30	30
1.7		Base departure time(s)	10	10	10	10
1.8		Total base running time(s)	66	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		45	5	50
5	Ce_i	Entrance approach capacities (vph)		631	1000	558
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	35	15	315	180
8	Cx_i	Exit approach capacities (vph)	742	562	576	558
9		Number of parking spaces occupied				
10	F	Emissions	78.84			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.44	0.02	0.64
14.4	Rx_i	Excess running time exiting parking lot	0.24	0.18	7.54	3.07
15	Te_i	Total entering running time (s/veh)		76.44	83.02	85.64
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	66.24	76.18	90.54	88.07
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	5.11 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE

Case # EXISTING Year 1988 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream 1(OUT)	2(IN/O)	3(IN/O)	4(IN/O)
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	66	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		37	4	41
5	Ce_i	Entrance approach capacities (vph)		660	1000	517
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	29	12	258	148
8	Cx_i	Exit approach capacities (vph)	752	601	611	580
9		Number of parking spaces occupied				
10	F	Emissions	50.02			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.32	0.01	0.44
14.4	Rx_i	Excess running time exiting parking lot	0.19	0.12	4.31	2.13
15	Te_i	Total entering running time (s/veh)		76.32	83.01	85.44
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	66.19	76.12	87.01	87.13
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.60 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE

Case # NO BUILD Year 1994 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	Brt	Base running time	1(OUT)	2(IN/O)	3(IN/O)	4(IN/O)
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	66	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		49	5	50
5	Ce_i	Entrance approach capacities (vph)		631	1000	543
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	35	64	347	389
8	Cx_i	Exit approach capacities (vph)	742	562	569	532
9		Number of parking spaces occupied				
10	F	Emissions	52.61			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.08	0.02	0.67
14.4	Rx_i	Excess running time exiting parking lot	0.24	0.82	9.89	18.41
15	Te_i	Total entering running time (s/veh)		76.08	83.02	85.67
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	66.24	76.82	92.89	103.41
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	5.37 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE

Case # No Build Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units		Traffic Stream		
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	66	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume (vph)		40	4	41
5	Ce_i	Entrance approach capacities (vph)		660	1000	584
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	29	52	285	319
8	Cx_i	Exit approach capacities (vph)	752	601	607	575
9		Number of parking spaces occupied				
10	F	Emissions	33.30			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.35	0.01	0.47
14.4	Rx_i	Excess running time exiting parking lot	0.19	0.57	5.25	7.80
15	Te_i	Total entering running time (s/veh)		76.35	83.01	85.47
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	66.19	76.57	88.25	92.80
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.60 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE

Case # BUILD Year 1994 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream 1(IN)	2(IN/O)	3(IN/O)	4(IN/O)
1	Brt	Base running time	1(IN)	2(IN/O)	3(IN/O)	4(IN/O)
1.1		Base approach time(s)	16			
1.2		Base entrance time(s)	10			
1.3		Base movement-in time(s)	10			
1.4		Base stop, base start time(s)	10			
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	46	152	166	175
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification	-			
4	Ve_i	Entrance demand volume. (vph)	58	23	5	60.
5	Ce_i	Entrance approach capacities (vph)	1000	1000	1000	527
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)		93	564	472
8	Cx_i	Exit approach capacities (vph)		637	418	515
9		Number of parking spaces occupied				
10	F	Emissions	52.61			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot	0.06	0.08	0.02	0.88
14.4	Rx_i	Excess running time exiting parking lot		0.97	77.0*	76.73
15	Te_i	Total entering running time (s/veh)	46.06	76.08	83.02	85.88
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)		76.97	160.0*	161.73
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	11.18* g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

* BASED ON OPERATIONS WITH TRAFFIC CONTROL OFFICER

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE

Case # BUILD Year 1994 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	Brt	Base running time	1(IN)	2(IN/O)	3(IN/O)	4(IN/O)
1.1		Base approach time(s)	16			
1.2		Base entrance time(s)	10			
1.3		Base movement-in time(s)	10			
1.4		Base stop, base start time(s)	10			
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	46	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)	48	19	4	49
5	Ce_i	Entrance approach capacities (vph)	1000	1000	1000	570
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)		76	462	387
8	Cx_i	Exit approach capacities (vph)		665	473	560
9		Number of parking spaces occupied				
10	F	Emissions	33.30			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot	0.18	0.07	0.01	0.59
14.4	Rx_i	Excess running time exiting parking lot		0.70	77.0*	17.38
15	Te_i	Total entering running time (s/veh)	46.18	76.07	83.01	85.59
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)		76.70	160.0*	99.38
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	4.87*			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

* BASED ON OPERATIONS WITH TRAFFIC CONTROL OFFICER.

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE
Case # NO BUILD Year 1991 Averaging Time 1 Hour

Step	Symbol	Input/Units	Traffic Stream			
1	Brt	Base running time	1(OUT)	2(IN/S)	3(IN/O)	4(IN/O)
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	66	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		49	5	50
5	Ce_i	Entrance approach capacities (vph)		628	1000	537
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	35	64	347	389
8	Cx_i	Exit approach capacities (vph)	740	557	563	526
9		Number of parking spaces occupied				
10	F	Emissions	46.02			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.49	0.02	0.69
14.4	Rx_i	Excess running time exiting parking lot	0.24	0.84	10.27	19.43
15	Te_i	Total entering running time (s/veh)		76.49	83.02	25.69
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	66.24	76.84	93.27	104.43
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	4.72 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE

Case # NO BUILD Year 1999 Averaging Time 8 Hour

Step	Symbol	Input/Units	Traffic Stream			
			1 (OUT)	2 (IN/O)	3 (IN/O)	4 (IN/O)
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	66	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)		40	4	41
5	Ce_i	Entrance approach capacities (vph)		656	1000	579
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)	29	52	285	319
8	Cx_i	Exit approach capacities (vph)	751	596	601	569
9		Number of parking spaces occupied				
10	F	Emissions	29.24			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot		0.36	0.01	0.47
14.4	Rx_i	Excess running time exiting parking lot	0.19	0.58	5.40	8.07
15	Te_i	Total entering running time (s/veh)		76.36	83.01	85.47
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)	66.19	76.58	88.40	93.07
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	2.29 g/s			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

WORKSHEET 3 - AREA SOURCE EMISSIONS COMPUTATION

Area Source SOUTH GARAGE

Case # BUILD Year 1999 Averaging Time 1 Hour

Step	Symbol	Input/Units		Traffic Stream		
1	Brt	Base running time				
1.1		Base approach time(s)				
1.2		Base entrance time(s)				
1.3		Base movement-in time(s)				
1.4		Base stop, base start time(s)				
1.5		Base movement-out time(s)				
1.6		Base exit time(s)				
1.7		Base departure time(s)				
1.8		Total base running time(s)	48	152	166	170
2	A	Area of parking lot (m^2)				
3	i	Entrance approach identification				
4	Ve_i	Entrance demand volume. (vph)	74	29	5	67
5	Ce_i	Entrance approach capacities (vph)	1000	1000	1000	516
6	i	Exit approach identification				
7	Vx_i	Exit demand volume (vph)		101	617	488
8	Cx_i	Exit approach capacities (vph)		633	402	504
9		Number of parking spaces occupied				
10	F	Emissions	46.02			
11	Pc	Capacity of parking lot (veh)				
12	Rmi	Excess movement-in time(s)				
13	Fet	Facility emptying time(s)				
14		Excess running time				
14.1	Ve_i/Ce_i	Entering volume-to-capacity ratio				
14.2	Vx_i/Cx_i	Exiting volume-to-capacity ratio				
14.3	Re_i	Excess running time entering parking lot	0.29	0.11	0.02	1.04
14.4	Rx_i	Excess running time exiting parking lot		1.08	77.0 *	217.86
15	Te_i	Total entering running time (s/veh)	48.29	76.11	83.02	86.04
16	Rmo	Excess running time moving out of parking stalls (s/veh)				
17	Tx_i	Total exiting running time (s/veh)		77.08	160 *	302.86
18	Qa	Total emission rate from a parking lot (g/m^2 - s)	14.18 *			
19	Qa'	Area source emission rate without the emissions from internal road segment. i				

* BASED ON OPERATIONS WITH TRAFFIC CONTROL OFFICER

PRUDENTIAL CENTER REDEVELOPMENT

DRAFT PROJECT AND ENVIRONMENTAL IMPACT REPORT
Volume V: Wind Impacts

V

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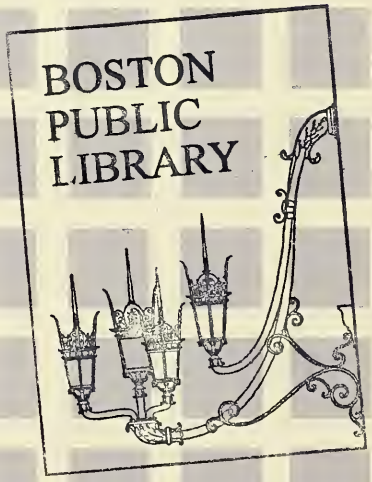
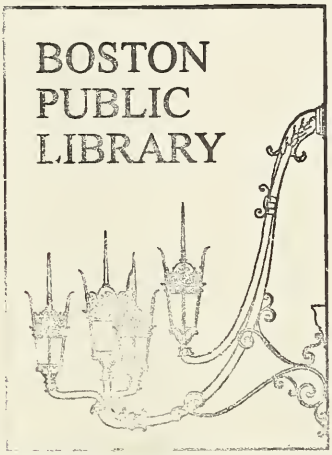


The Prudential Property Company, Inc.
for The Prudential Insurance Company of America

PRUDENTIAL CENTER REDEVELOPMENT

DRAFT PROJECT AND ENVIRONMENTAL IMPACT REPORT
Volume V: Wind Impacts

V



Wind Tunnel Study of Pedestrian Level Winds for Configurations A, C, A2, and C2 of the Prudential

April 12 1989

submitted to:
The Boston Redevelopment Authority
Massachusetts Executive Office of Environmental Affairs
Executive Office of Environmental Affairs Number: 7208

submitted by:
The Prudential Property Company, Inc.
for The Prudential Insurance Company of America

Frank H. Durgin and Gokhan Goktug, at
Wright Brothers Memorial Wind Tunnel, MIT

DRAFT PROJECT AND ENVIRONMENTAL IMPACT REPORT

PROJECT

Prudential Center Redevelopment
Boston, Massachusetts

DEVELOPER

The Prudential Property Company, Inc., for The Prudential Insurance Company of America

STATUS OF PROJECT

The developer submitted a Project Notification Form to the Boston Redevelopment Authority (BRA) and an Environmental Notification Form to the Massachusetts Executive Office of Environmental Affairs (EOEA) on June 29, 1988. Scoping letters were issued to the developer by the BRA and EOEA on September 1, 1988. The EOEA number is 7208. The project is in pre-schematic design stage. Master plan approval is being sought.

BRIEF DESCRIPTION OF THE PROJECT

The project includes the addition of new offices, retail spaces and housing to the current Prudential Center site. New housing and offices, with retail uses at their base, will be constructed principally along the Boylston Street, Huntington Avenue and Belvidere Street frontages. The current retail area will be reconstructed and expanded with indoor pedestrian passageways. Enclosed pedestrian routes will provide connections between Boylston Street and Huntington Avenue, and between Copley Place and the south entrance of the Hynes Convention Center. A system of public squares, a wintergarden and outdoor open spaces will be created as amenities for those using the center and adjacent neighbors. A neighborhood commercial area, including an expanded supermarket, is proposed for Huntington Avenue and East Ring Road. East Ring Road will be improved to facilitate pedestrian flows to the shopping area. The existing parking garages will remain approximately the same size, but their capacity will be expanded by approximately 800 spaces through changes to their management.

ALTERNATIVES CONSIDERED

Two basic planning approaches have been considered for the site, and for each three scales of building program have been analyzed. Alternative A proposes two new office structures along Huntington and principally housing, with a small office structure, along Boylston. Alternative A2 has housing as well as offices along Huntington Avenue and housing, along with expanded offices, along Boylston Street. The form of structures, their heights, and the organization of pedestrian routes also vary between these two basic alternatives. Alternatives B and B2 are similar in configuration, respectively, to Alternatives A and A2, but the overall development totals 10 percent less area. Alternatives C and C2 follow the same outlines, but are 20 percent smaller in area than Alternatives A and A2. In the course of preparing these plans, a large number of other design and functional alternatives were considered and rejected as less desirable.

DEVELOPMENT PROGRAM

The three basic levels of program studied are, as follows:
(000 FAR gross sq. ft.)

Use	Alternatives A and A2	Alternatives B and B2	Alternatives C and C2
Offices	1,009	865	811
Residential	404	378	324
Retail	268*	210*	160*
Total Areas	**1,681**	**1,448**	**1,295**
Plus Indoor Pedestrian Areas	153**	153**	103**
TOTAL PROGRAM	**1,834**	**1,601**	**1,398**

* In addition, 143,000 gross sq. ft. of existing retail is demolished and rebuilt.

** Areas vary slightly between alternatives.

DEVELOPMENT SCHEDULE

The project is planned as a number of separate phases to be completed over a 10 year period. Construction will begin on the south side of the site, moving to the north. Phases along Huntington Avenue should be completed by 1994, with the Boylston Street area completed by 1999.

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IA: Summary Appendix
II: Urban Design Alternatives
III: Transportation Access Plan
IIIA: Transportation Access Plan Appendix
IV: Environmental Impacts
V: Wind Impacts
VA: Wind Impacts Appendix
VI: Infrastructure Systems
VII: Housing Impacts
VIII: Public Benefits
D: Drawing Set

FOREWORD

The authors would like to thank Gary Hack and Mary Jane Daly of Carr, Lynch, Hack and Sandell for their cooperation and assistance throughout the wind tunnel testing of the Prudential Center Redevelopment and the writing of this report.

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WIND TUNNEL STUDY OF PEDESTRIAN LEVEL WINDS FOR CONFIGURATIONS A, C, A2, AND C2 OF THE PRUDENTIAL CENTER REDEVELOPMENT

Frank H. Durgin
Gokhan Goktug

1. INTRODUCTION

This is the second in a series of studies designed to obtain estimates of the occurance of pedestrian level winds for various configurations of the proposed Prudential Center Redevelopment. In the first (reference [15]) configurations "Build" and "Build 2" were investigated. Predicted 100 hour return period equivalent average wind speeds at 101 locations in each configuration were compared with those for the same locations in the complex as it exists today (Figures 5a-e). In this second study, proposed configurations A (Figures 6a-e), C (Figures 7a-e), A2 (Figures 8a-e), and C2 (Figures 9a-e) were investigated. Configurations B and B2 (different than "Build" and "Build 2") are also being considered at this time, but were not tested. The differences among configurations A, B, and C is primarily in the heights of the buildings (A has the tallest and C has the lowest) so that it was felt the predicted wind speeds for configuration B would fall between those of A and C. Configuration B2 has a similar relationship to configurations A2 and C2.

The Prudential Center Redevelopment site is located in Boston's Back Bay and is bounded by Boylston St., Huntington Av., Dalton St., and Exeter St. The existing site is composed of several high-rise buildings, including the 770-foot Prudential Tower and three 300-foot residential towers. It is situated adjacent to several major office buildings, including the John Hancock Tower, 500 Boylston St., and the Westin and Marriott hotels in Copley Place. The Prudential Center Redevelopment Project proposes the development of additional housing, office, and retail space among the major buildings of the existing complex, as well as a pedestrian walkway connecting Copley Place to the new Hynes Convention Center.

This pedestrian level wind study of the project area was performed at the Wright Brothers Facility (WBF) of the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology. An erosion technique, which results in qualitative wind data, was used.

The erosion tests were performed to obtain predictions of the occurance of pedestrian level winds in the vicinity of the site for the four configurations tested in order to determine the effect of each proposed configuration relative to the others and to the "Existing" conditions for which data exists from the previous study [15]. The results of the erosion tests can also be used as a guide for any future quantitative wind tunnel tests using the hot-wire technique.

The erosion technique (Section 3) is a qualitative method of examining the winds at pedestrian level and is used primarily to determine the windiest locations in the vicinity of a project site. Prior to the initial testing, 116 locations were selected for observation. The locations were chosen based on (1) those used in the previous study [15], (2) the expectation of pedestrian activity and/or (3) significant windiness. Although the choice of these locations for analysis was somewhat arbitrary, the photographs allow the evaluation of wind conditions at any location. The discussion of the results will be limited to the 116 chosen stations.

The primary data consists of photographs of the erosion patterns of plastic, rice-like particles, which were uniformly spread on the model and subjected to steadily increasing wind velocities. Photographs were taken at each of 7 gradient wind speeds (0, 10, 13, 17, 23, 30, and 40 mph), and 16 wind directions (NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW, and N). These photographs have been examined to determine the minimum gradient wind speed at which the particles were eroded away from the 116 locations for each of the 16 wind directions tested. Combining those wind speeds with a statistical description of the Boston wind climate resulted in a prediction of the 100-hour return period equivalent average velocity at each station. The 100-hour return period velocity is the maximum wind speed which can be expected to occur during 1 hour every 100 hours, or 1 percent of the time.

The equivalent average wind speed used to make these evaluations (Section 4.2) takes into account three different types of windiness: (1) average winds, or the fastest hourly average wind speed; (2) effective gust velocity, or the fastest 1-minute average wind speed; and (3) peak gust velocity, or the fastest 2- or 3-second gust occurring in a 100-hour time period. When used with Melbourne's criteria (Section 5.2) for 100-hour return period equivalent average velocity, these wind speeds provide a means of evaluating the relative wind conditions at each location with respect to different kinds of pedestrian activity for each configuration. However, it should be noted that the nature of the erosion test somewhat limits the accuracy of the evaluation.

Annual results of this and the previous tests are summarized Table 3. Those for winter, spring, summer and fall are given in Tables 4-7 respectively. In those tables the total number of locations falling in each of Melbourne's categories is listed for each configuration tested. In general the configuration with the most locations in the highest numbered categories [4 and 5] is the least windy.

No location in any configuration or time period falls in Melbourne's Category 1, unacceptable, dangerous. Annually two locations exceed the BRA guideline wind speed and up to 9 locations (Configuration C) fall in Category 2, uncomfortable for walking. In general, Configuration A2 is noticeably windier than "Existing" conditions. Configuration C is just about as windy. The "Build 2" configuration is clearly the least windy; and the "Build", A, and C2 configurations are the same or slightly less windy than "Existing" conditions.

Basic information about the experimental equipment, acquisition and reduction of data, and evaluation of results is presented in the main body of the text in Volume I. The appendices in Volume II provide additional material on the technical portions of this report and photographs of each of the configurations tested. The erosion wind speeds, annual and seasonal weibull constants, and percent contributions are provided in Volume II in Tables A3-A17. For quick reference, Tables 3-7 and Figures 13-17 were prepared to summarize all data used in the evaluation of the test results.

Information about the wind tunnel, the test equipment, and the test configurations is given in Section 2 and discussed further in Appendix I in Volume II. Appendix II, also in Volume II, discusses the calibration of the boundary layer (Section 2.1) used in the test. Section 3 provides an in-depth explanation of the erosion technique. The method of data reduction is presented in Section 4 and discussed in more detail in Appendix III. Melbourne's criteria are discussed in Section 5 and described more fully in Appendix IV. All Appendices are in Volume II. Results are presented in Section 6, discussed in Section 7, and summarized in Section 8.

2. THE EXPERIMENTAL EQUIPMENT

2.1 THE WIND TUNNEL AND APPROACH FLOW

All testing was conducted in the Wright Brothers Memorial Wind Tunnel, a diagram of which is shown in Figure 1. Although this wind tunnel was designed primarily for aeronautical testing, relatively simple modifications allow it to be used for pedestrian level wind studies, such as that performed for the Prudential Center Redevelopment study.

Due to resistance to the wind created by the ground, trees, buildings, and other obstructions near ground level, the wind speed at pedestrian level is not the same as the wind speed at greater heights. The wind velocity, which is zero at the ground surface, increases exponentially up to a height of 900-1800 feet, depending on the type of terrain upwind of the site. The region in which the wind velocity increases with height is commonly referred to as the "atmospheric boundary layer," and the 900-1800 foot height, above which the wind velocity is constant, is called the "gradient height." The atmospheric boundary layer, sometimes called the approach flow, is modeled in the wind tunnel using spires and roughness blocks placed in the test section upstream of the modeled city, as shown in Figure 2. Given the nature of the Prudential Center Redevelopment site and the surrounding area, a suburban type approach flow was used. The resulting atmospheric boundary layer was measured in the wind tunnel and is believed to be appropriate for this test. An in-depth discussion of the calibration of the boundary layer is presented in Appendix II in Volume II.

2.2 THE MODEL

The approach flow simulates the atmospheric boundary layer after passing over the spires and roughness blocks, and prior to passing over a model of the city positioned on the turntable. The model of the Back Bay section of Boston used in the Prudential Center Redevelopment study (Figure 3) was constructed at a scale of 1:600. The model includes all existing buildings within 2400 feet of the center of the project site and has been used in a number of other wind tunnel studies [11, 13, 19, and 34]. The model underwent extensive upgrading to make it as accurate as possible for the previous test and was further upgraded for this test, particularly to the west of Massachusette Avenue. The following projects now under construction, recently completed, or proposed were included in the model:

500 Boylston Street
Hynes Convention Center
30 Garrison Street
32 Garrison Street
56 St. Botolph Street
The Fenway Health Center on Haviland Street
116 Huntington Avenue
The proposed 25 Huntington Avenue complex was deliberately left out and the existing buildings used instead.

The buildings bounding the Prudential Center Redevelopment site were modeled in more detail than buildings further away. The Prudential site itself occupies an area of approximately three square feet at the center of the turntable.

The basic area model was an eight foot (4800 ft full scale) diameter circle centered just east of the Prudential Tower. However, becausee of its use in references [11, 13, 19,and 34] significant additional sections outside the basic model were available and installed upstream of the basic model whenever possible as indicated in Figure 3. As a result the minimum distance of any point in the Prudential Center site to the upstream edge of the model was about 1800 feet.

3. THE EROSION TECHNIQUE

The erosion technique provides a means of qualitatively measuring wind speeds in the vicinity of a project and has been extensively used over the last six years at WBF [9, 10, 11, 13, 14, 15, 16, 19, 29, 34, 35]. To perform such tests, rice-like, plastic particles are spread one layer thick over the surface of the model. Two cameras are mounted at the top of the wind tunnel, facing down toward the model. Pictures of the model are then taken at wind tunnel gradient height wind speeds of 0, 10, 13, 17, 23, 30, and 40 mph. This process is repeated for each of 16 wind directions (NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW, N). From these sets of pictures it was possible to determine the approximate speed at which the particles were swept away from each of the 116 locations evaluated in the test. For example, the windiest locations are those in which the particles are swept away at the lowest gradient height wind speeds (13-23 mph), while the retention of particles at 40 mph indicates a calm location. Listings of the gradient height speeds at which the particles were swept away for each of 116 stations and 16 directions are given in Tables A3 - A7 in Volume II. Table A3 contains the wind speeds for "Existing" conditions from the previous test [15]. The wind speeds for the locations 102-116 were obtained from the photographs in reference [15]. These wind speeds were used to predict the 100-hour return period equivalent average velocities (Section 4.2).

Although the results from the erosion study have been used to obtain estimates of the 100-hour return period equivalent average velocities, the primary purpose of the data from this type of test is to provide qualitative estimates of the effects of adding the proposed buildings to the existing model. For this study of the Prudential Center Redevelopment, four different configurations were tested; Configurations A, C, A2, and C2. Results from several studies [9, 10, 11, 20, 35], in which both the erosion and hot-wire techniques were used to obtain estimates of the 100-hour return period velocities, indicate that the expected difference in velocity prediction between the two types of tests is usually no more than $\pm$ 3 mph.

4. REDUCTION OF DATA

4.1 INTRODUCTION

The primary data from this erosion study consists of the sets of photographs taken of the eroded particles which appear for each of the four configurations in Volumes III A - III D respectively. Overall, there are 896 different photographs -- 224 in each volume; one from each of the two cameras showing the erosion effects at each of the 7 wind velocities for each of the 16 wind directions. While all the information is contained in the photographs, it is hard to evaluate the total effect of the wind environment at any location given any one photograph or even an entire set of the photographs. To evaluate the relative windiness of the project area, 116 locations were chosen for examination (Figures 5 -9). The 116 locations are given for each configuration tested, because some were moved slightly to insure they were near an exit and others were covered by buildings. The shaded areas in the complex in each figure indicate areas of expected pedestrian actiivity.

The gradient height velocities in the wind tunnel at which the particles first eroded away from each location and wind direction were determined from the photographs and recorded. These velocities are given in Tables A3-A7 in Volume II.

4.2 THE EQUIVALENT AVERAGE

A high average wind, high gustiness, or an infrequently occurring strong peak gust can cause a particular location to be perceived as windy. The "equivalent average velocity" concept was developed as a single quantity that included the effects of each of these types of winds and could be used for the evaluation of pedestrian level wind speed measurements made in hot-wire studies.

In a hot-wire study, the 100-hour return period average, effective gust, and peak gust wind speeds are determined for each location. The "equivalent average velocity" is defined as the largest of: (1) the average wind speed; (2) the effective gust velocity divided by 1.43; or (3) the peak gust velocity divided by 2.00.

If the predicted average, effective gust, and peak gust velocities are obtained for many stations, 1.43 is the average ratio of effective gust to average predicted wind speed and 2.00 is the average ratio of the peak gust to average predicted wind speed. Thus, for an "average" location the three quantities defined above would be equal.

If the winds at a particular location are dominated by any one of the three, it will be that one which determines the equivalent average.

In this way the "equivalent average velocity" accounts for high average winds, high gustiness and the unusually strong peak gust. The 100-hour return period equivalent average velocities can be used with Melbourne's criteria (Section 5.2) to determine the type of pedestrian activity that is appropriate at each station.

Several studies at WBF have shown that when an equivalent average velocity of 9.0 mph is assumed for the pedestrian level wind speed at which the particles begin to erode, the results for an erosion study generally agree within 2-3 mph of those for a hot-wire study [9, 10, 11, 34, 35].

It is important to remember that the equivalent average velocity takes into account the average wind speed, the gustiness, and the peak gusts, as noted above. Because it uses the most severe of the three velocity types, this method is a more conservative way of evaluating pedestrian level winds than methods which consider only average or effective gust velocities.

4.3 DIRECTION CONTRIBUTIONS TO THE EQUIVALENT AVERAGE

The occurrence of a given gradient wind speed is not equally probable for all directions (Figure 10). Further, the relative wind at any location is a function of direction. If measures are proposed to reduce adverse pedestrian level winds at a particular location, it is important to know which gradient wind direction contributes the most to the 100-hour return period winds. For this purpose, the percentile contributions to the annual 100-hour return period equivalent average velocity from each of the 16 compass directions are given in Table A13-A17 of Volume II. In general, any one wind direction contributing more than 30 percent to the probability of the occurrence of the 100-hour return period wind should be investigated. Of course, the mechanisms causing these winds must also be determined for each of the critical directions before effective mitigation measures can be taken.

5. CRITERIA

5.1 THE BRA EFFECTIVE GUST VELOCITY GUIDELINE

In order to evaluate the impact of pedestrian level winds, wind speed criteria or guidelines are necessary. The Boston Redevelopment Authority (BRA) uses a 100-hour return period effective gust guideline velocity of 31 mph. The effective gust velocity is defined as the average wind speed plus 1.5 times the rms (root mean square variation about the average) wind speed. This effective gust guideline velocity is referred to as the BRA guideline. The 31 mph effective gust roughly corresponds to the fastest 1-minute gust occurring each 100 hours.

To convert the BRA effective gust velocity to an equivalent average velocity, the effective gust velocity is divided by 1.43, which gives a value of 22 mph. Values above 22 mph are considered unacceptable by the BRA. Although the effective gust velocity is not obtained directly from the erosion study data, its value at any location can be approximated from the equivalent average velocity by using the relation given above. No location in any of the four tested configurations had an annual predicted equivalent average velocity that exceeded the BRA guideline velocity. However, the predicted annual wind speeds at location 20 in Configuration C and at location 57 in configuration A2 were 22mph and thus equaled the guideline wind speed.

5.2 MELBOURNE'S CRITERIA

The other wind speed criteria used to evaluate pedestrian level winds for the Prudential Center Redevelopment Project are those developed by W. H. Melbourne [24]. It is our understanding that these criteria are currently being adopted by the BRA. In 1978, Melbourne conducted a literature review to find probabilistic criteria for hourly average pedestrian level winds that would reflect different types of human activity, as well as safety considerations. The results of that study are summarized in Figure 12 in this Volume and Figure A16 in volume II. The criteria are described in detail in Appendix IV in Volume II. The vertical scale in Figure 12 is the average hourly wind speed in miles per hour and the horizontal scale is the probability of that average wind speed actually occurring based on the number of hours. Five comfort criteria levels are given. They are: 1) "unacceptable and dangerous," 2) "uncomfortable for walking," 3) "acceptable for walking," 4) "acceptable for short periods of standing or sitting," and 5) "acceptable for long periods of standing or sitting."

These criteria, as defined for 100-hour return period average velocities, have been in use at the WBF since 1979, and since 1985 have been applied to 100-hour return period equivalent average velocities. The results, when the horizontal scale is limited to a maximum probability of occurrence P(U>Up)=0.001 (1000 hours), are given in Figure 12. The corresponding BRA guideline velocity is also identified in Figure A16 by a circumscribed star symbol.

Melbourne's criteria cover all probabilities, as shown in Figure 12. Considering winds with a 100-hour return period (1 percent probability) occurrence, his criteria can be restated as follows:

TABLE 1

MELBOURNE'S CRITERIA FOR 100-HOUR RETURN PERIOD EQUIVALENT AVERAGE VELOCITY

CATEGORY	DESCRIPTION	VELOCITY (mph)
1	UNACCEPTABLE-DANGEROUS	27≤Uav
2	UNCOMFORTABLE FOR WALKING	19≤Uav<27
3	ACCEPTABLE FOR WALKING	15≤Uav<19
4	STATIONARY SHORT EXPOSURE	12≤Uav<15
5	STATIONARY LONG EXPOSURE	Uav<12

Melbourne's criteria are subjective and expressed in probabilistic form. They are based on the work of eight different authors. The criteria in the table above suggests that if the 100-hour return period equivalent average velocity exceeds 27 mph, then the wind at that location will exceed 27 mph, often enough to make that location dangerous. Similarly, if the 100-hour return period equivalent average velocity is less than 12 mph, then the location will not seem windy at all, and one can stand or sit comfortably for long periods of time.

The equivalent average velocities (Tables 8 - 13), defined in Appendix IV, are compared with Melbourne's criteria for average velocities to evaluate the results for this test. The annual Melbourne categories for all locations are found in Table 8. An asterisk would appear next to the Melbourne category in both the maps and tables if the equivalent average velocity for that station exceeded the BRA guideline velocity in equivalent average form. However, none of the annual predicted velocities exceeded the guideline in this study. As noted above, location 20 in Configuration C and 57 in Configurtion A2 did have predicted velocities equaling it.

The dotted line in Figure A15 shows the estimated wind conditions at an elevation of 4.5 feet at Boston's Logan Airport. Note that the dotted line lies above Melbourne Category 3: "acceptable for walking," and slightly below the BRA guideline criteria of 22 mph. This means that wind conditions at Logan Airport would be termed "uncomfortable for walking" by Melbourne's criteria, but would be acceptable by the BRA guideline.

In order to provide some basis for comparison of the velocities in Figures 13-17 and Tables 8-13, Table 14 has been included. This table is based on Admiral Beaufort's wind scale, as interpreted by Penwarden [30], for pedestrian level winds. The velocities used in Table 14 appear to be defined similarly to the effective gust velocity used by the BRA, as indicated in the footnote. Thus they are 1.43 times larger than the equivalent average velocities used in this report. The 100-hour return period guideline velocity of 31 mph, used by the BRA as the effective gust wind velocity, is at the dividing line between Beaufort Categories 6 and 7. When Melbourne's dividing line velocity of 19 mph, between Category 3: "acceptable for walking" and Category 2: "uncomfortable for walking," is multiplied by 1.43, it corresponds to an effective gust of 27 mph, and falls in the middle of Beaufort Category 6.

6. DESCRIPTION OF RESULTS

The results of the pedestrian level wind study for the Prudential Center Redevelopment Project are contained in the photographs in Volumes III-A, III-B, III-C, and III-D and in Tables A3 - A7. The photographs contained in the four volumes were used to obtain the data needed to develop Tables A3-A7. Each volume contains all the photographs taken with Camera I (28 mm lens) and Camera II (35 mm lens) for one of the configurations tested. These four sets of pictures are contained in Volumes III-A (configuration A), III-B (Configuration C), III-C (Configuration A2), and III-D (Configuration C2) of this report. Only five copies of each photograph were made, making distribution of Volumes III-A-D limited.

The photographs were examined for each wind direction and configuration to determine the gradient wind speed at which each of the 116 locations became clear of particles. The first set of tables (A3-A7) in Volume II lists those gradient wind speeds for each location and wind direction. The reciprocals of the wind speeds given in the these tables were multiplied by 9.0 mph, which is the equivalent average pedestrian level (4.5 ft) wind speed assumed to cause the particles to erode. Combining these velocity ratios with a statistical description of the Boston wind climate resulted in an estimate of the 100-hour return period equivalent average velocity and the Melbourne category for each location. Tables (8-13) contain those estimated wind speeds and associated Melbourne categories for all the configurations tested both here and in reference [15] for both annual and seasonal time periods. Lastly, the percentile contributions from each of the 16 wind directions for annual time periods are given in Tables A13-A17. The latter tables are very useful in determining at which times of the year each station will be the most windy, as well as in estimating the effectiveness of any proposed mitigation measures.

The station locations used in the last five sets of tables are shown in Figures 5-9. The estimates of the annual 100-hour return period equivalent average velocities for each location and configuration are presented in summary form in Figures 13 -17 and Tables 8 -13. There are five maps per figure number for the station locations (Figures 5-9), and equivalent average velocities (Figures 13-17). The five different station location maps are included because it was necessary to move certain stations slightly between major configuration changes and some locations are covered with buildings for some configurations. Since the Prudential site is very large, it was necessary to split the maps into four quadrants (NW, NE, SW, and SE) and a central

portion, for ease in locating and reading the various values. One global map is included in Figure 4 to help reference the various smaller maps.

7. DISCUSSION OF RESULTS

7.1 COMPARISON WITH PREVIOUS RESULTS

The predicted wind speeds obtained for the "Existing" configuration were compared with those from a previous test with corresponding stations in reference [15]. That comparison is repeated below.

Table 2 compares ten stations from the "Existing" configuration and the 25 Huntington Av. study performed in May 1987 [19]. The "Existing" configuration of the Prudential Center Redevelopment study and the "Build" configuration of the 25 Huntington Av. study used identical models and therefore their comparison is a good measure of data repeatability.

Table 2.

COMPARISON OF EQUIVALENT AVERAGE VELOCITIES (mph) FROM PRUDENTIAL CENTER AND 25 HUNTINGTON AV. STUDIES

Prudential Center		25 Huntington Av.	
Station	Velocity	Station	Velocity
51	12	10	9
52	10	5	10
54	9	9	9
55	10	7	12
56	14	6	13
57	17	11	17
59	11	4	8
61	7	2	8
63	16	1	16
83	16	31	17

The average velocity difference between the ten stations is 1.1 mph, which is well within the expected repeatability $\pm$ 3 mph for erosion testing.

7.2 ANNUAL 100-HOUR RETURN PERIOD EQUIVALENT AVERAGE VELOCITIES AND MELBOURNE CATEGORIES

All stations in the Prudential Center Redevelopment Project study recorded estimated annual 100-hour return period velocities between 7 and 22 mph. Most of these velocities are quite modest and indicate comfortable pedestrian level wind conditions. There are three distinct areas which consistently show annual predicted equivalent average wind speeds in Melbourne Categories 4 or 5 for all configurations. These areas are: 1) much of both sides of Boylston St. between Hereford St. and Dartmouth St.

(stations 24, 25, 28-32, 34, 36-39, 87, 88, 41, 42, 116, 44-48, 50, and 51); 2) the west and south sides of the Boston Public Library (stations 52-55); and 3) the north side of Huntington Av. between Ring Rd. and Exeter St. and opposite the Colonade Hotel (stations 60, 61, 70, 71 and 73). Other locations which show predicted wind speeds in categories 4 and 5 for all configurations are 8, 9, 11-14, 21, 22, 58, 59, 66, 68, 70, 71, 73, 85, 97, 101, 103, 111, 113, and 114. That is 54 of 116 stations are always in categories 4 or 5 and from Table 3 the actual mimimum number in these two categories is 65 for Configuration A2. The maximum was 82 for the "Build 2" and A configurations.

In addition to these relatively calm areas, there are a few locations which experience consistently high equivalent average velocities for one or more of the seven configurations. The only ones near a pedestrian entrance are stations 17 and 18 at the corner of Dalton St. and Belvedere St, near the entrance to the Hilton Hotel and these are relatively windy for all but the "Build 2" configuration. station 20 at the entrance to the Sheraton garage is probably the windiest in the site, but is not in an area of pedestrian activity, nor is the predicted wind speed there dramatically effected by any of the proposed configurations.

Other windy areas are: 1) The courtyard south of the Prudential Tower (stations 75, 76, 77, 78, 80, 81, and 82)(the diagonal covered walkway near the SE corner of the tower in configurations "Build", "Build 2", and A noticably reduces the winds at station 82 and 78); 2) Some stations in the areas surrounding the three existing apartment towers (stations 95, 96, 102, and 105; 3) stations 6, near the Christian Science office tower, 57, at the point of the Westin Hotel (Stuart St. and Huntington Av.), 63, at Harcourt St. and Huntington Av., and 40 at the NE corner of Exeter and Boylston Streets.

Table 9 lists the differences between the predicted annual equivalent average winds for each proposed configuration and "Existing" conditions. Differences less than 3 mph are not considered significant because of the limited accuracy of the erosion technique. Changes of 5 or more certainly are significant and 11 stations (33, 34, 35, 43, 61, 62, 63, 73, 107, 108, and 115) have increases of 5 or more for one or more of the configurations. The increases at all but stations 63 and 115, are due to the change from an being an open space to being in proximity to one of proposed buildings. station 63 at the corner of Harcourt Street and Huntington Avenue is windy now, and when the taller towers are added in configurations A and A2 becomes more windy and is in in Melbourne's Category 2 for those two configurations. The most dramatic increase occurs

at station 115 at the entrance to the proposed new Star Market. Even so the station is in Melbourne's Category 3, comfortable for walking. This increase occurs at station 115 for Configurations A, C, A2, and C2 probably due to the increased height of the Star Market Building for those configurations.

On the average, the 116 stations represented in the "Existing" configuration have equivalent average velocities of 12.9 mph. The "Build" and "Build 2" configurations without stations 102 to 116 have averages of 12.7 and 11.5 mph. Configurations A, C, A2, and C2 with 109, 113, 109, and 114 stations have average predicted wind speeds of 12.6, 13.6, 14.0, and 13.0 mph respectively. On balance configuration "Build 2" is less windy than "Existing" conditions; configurations "Build", A, and C2 are about the same and configurations C and A2 are significantly windier. Noting the total number of stations in categories 4 and 5 in Table 3 leads to the same conclusion.

7.3 ANNUAL MELBOURNE CATEGORIES AND COMPARISON WITH THE BRA GUIDELINE WIND SPEED

Annually only two of the stations in any of the seven tested configurations (57 in C and 20 in A2) exhibited velocities which exceeded or equaled (both just equaled) the BRA guideline equivalent average velocity of 22 mph.

Most stations in all seven configurations fall into comfortable Melbourne categories (3, 4, and 5). The "Existing" configuration and configurations C and A2 all have 8 or 9 stations in Category 2: "uncomfortable for walking." Seven of these stations (20, 49, 57, 63, 78, 82,and 96) are common to at least two of the three configurations. None are at entrances and 20, 49, 57, 63, and 96 are isolated at the end of a building or at a corner. 78 and 82 are located in the courtyard south of the Prudential Tower.

Configurations "Build", A, and C2 have 3 or 4 stations in category 2 and again, stations 20, 57, and some of the stations in the courtyard to the south of the tower, are common to two or more of the three. Configuration "Build 2" has no stations in category 2. Thus, again we find that configurations "Build", A, and C2 are significantly less windy than C, and A2, and here less windy than "Existing". "Build 2" is the least windy of all.

7.4 SEASONAL RESULTS

The seasonal results are given in Tables 9-12 and the Melbourne Categories are summarized in Tables 4-7. In general the seasonal results follow the trends shown in Figure 11 in which the average wind speed in Boston over the period of time 1945-1965, is plotted versus time by the month for one year. That is, in the winter (January, February, and March) the winds are highest; those in spring (April. May, and June) are next highest and still greater than for the whole year; those in summer (July, August, and September) are the lowest; and those in the fall (October, November, and December) are not as low, but still significantly lower than for the whole year.

Forinstance, for "Existing" conditions the predicted year round average is 12.9 mph for the 116 stations tested. For winter, spring, summer, and fall it is 13.8, 13.4, 10.4, and 12.3 mph respectively. Of course the prevailing wind direction also changes with the seasons so that NW winds dominate in the winter and SW winds in the summer. For that reason the predicted occurance of wind speeds at a given station will not always follow the overall trends.

The effect of the above noted changes in wind direction with the seasons becomes apparent when one examines the number of stations in each configuration whose predicted 100 hour return wind speeds exceed the BRA guideline equivalent average velocity of 22 mph (see Tables 4-7). Where as, for the whole year only two stations, one each in confugurations C and A2, exceed the BRA guideline wind speed, in the winter 22 stations exceed it (3 in "Existing", 3 in "Build", 3 in A, 5 in C, 6 in A2, and 2 in C2). In the spring the total number drops to 6 (1 in A, 2 in C, 2 in A2, and 1 in C2). In the summer and fall none in any configuration exceed the BRA guideline wind speed.

7.5 USE OF TABLES A10-A12

Tables A10-A12 list the percentile contribution of each of the 16 wind directions to the predicted total 100-hour return period occurrence of winds at each station for each configuration. The data in these tables can be used to determine the wind directions causing the windiness at any given station. Consider station 78 in the "Existing" configuration, located in the courtyard south of the Prudential Tower. Table A10 shows that 92% of the 1 percent probability of winds occurring at that station are due to west-northwest winds. This implies that station 78 will be quite windy during northwest storms, which occur mainly in the winter months. If some mitigation measure is found to diffuse the winds at that location due to these northwest

winds, then the 20 mph estimated 100-hour return period wind velocity could be reduced considerably.

To examine any particular station in Tables A10-A12, they should be split into three distinct groups: (1) the eastern half, associated with the precipitation period of storms; (2) the southwest quadrant, associated with summer winds; and (3) the northwest quadrant, associated with winter winds. The choice of these divisions follows directly from statistical wind information shown graphically in the Boston Wind Rose (Figure 10). A division which has a 25 percent contribution from any station is considered significant. In Table A10, representing "Existing" conditions, nearly 60% of the 116 stations have at least a 25 percent contribution in the eastern half. This contribution is also evidenced at over 25% of the stations for the southwest quadrant and 65% of the stations for the northwest quadrant. Because some stations have at least a 25 percent contribution in two different divisions, these three percentages do not add up to 100.

8. SUMMARY OF RESULTS

The pedestrian level wind study of the Prudential Center Redevelopment, using the erosion technique, has shown that, in general, winds in the vicinity of the project are quite modest. No station in any configuration or time period falls in Melbourne's Category 1, unacceptable, dangerous. Annually two exceed the BRA guideline wind speed and up to 9 (Configuration C) fall in Category 2, uncomfortable for walking. In general, Configuration A2 is noticably windier than "Existing" conditions. Configuration C is just about as windy. The "Build 2" configuration is clearly the least windy; and the "Build", A, and C2 configurations are the same or slightly less windy than "Existing" conditions. In the winter 5 or 6 stations in configurations A and C2 will exceed the BRA guideline predicted wind speed of 22 mph.

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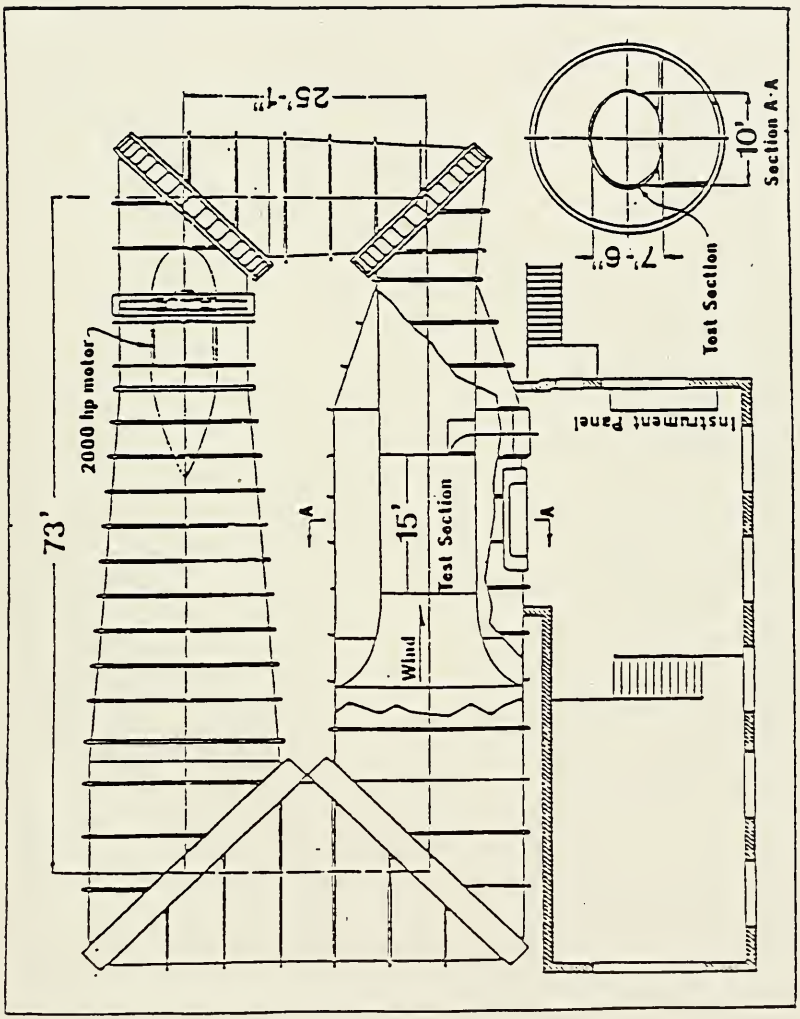


Figure 1. Schematic Diagram of Wright Brothers Wind Tunnel

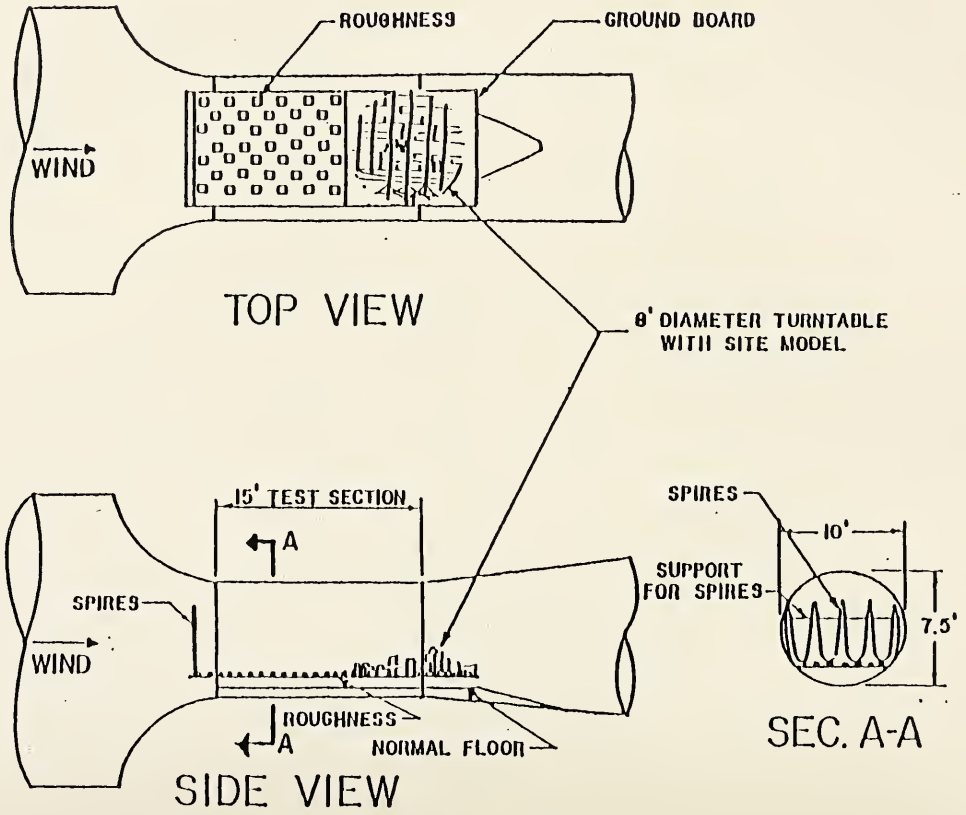


Figure 2. Schematic of the Typical Setup Used to Simulate the Earth's Boundary Layer

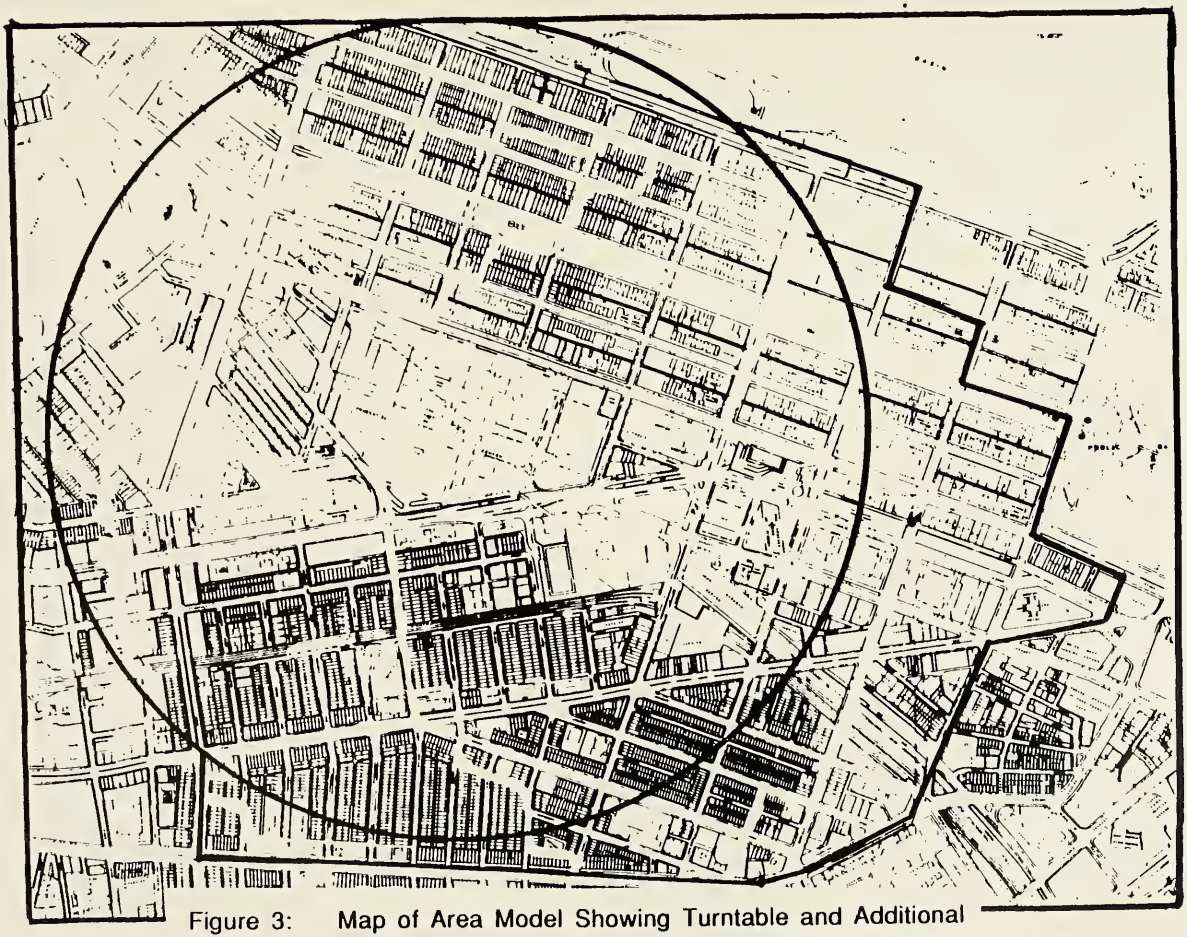


Figure 3: Map of Area Model Showing Turntable and Additional Sections Used

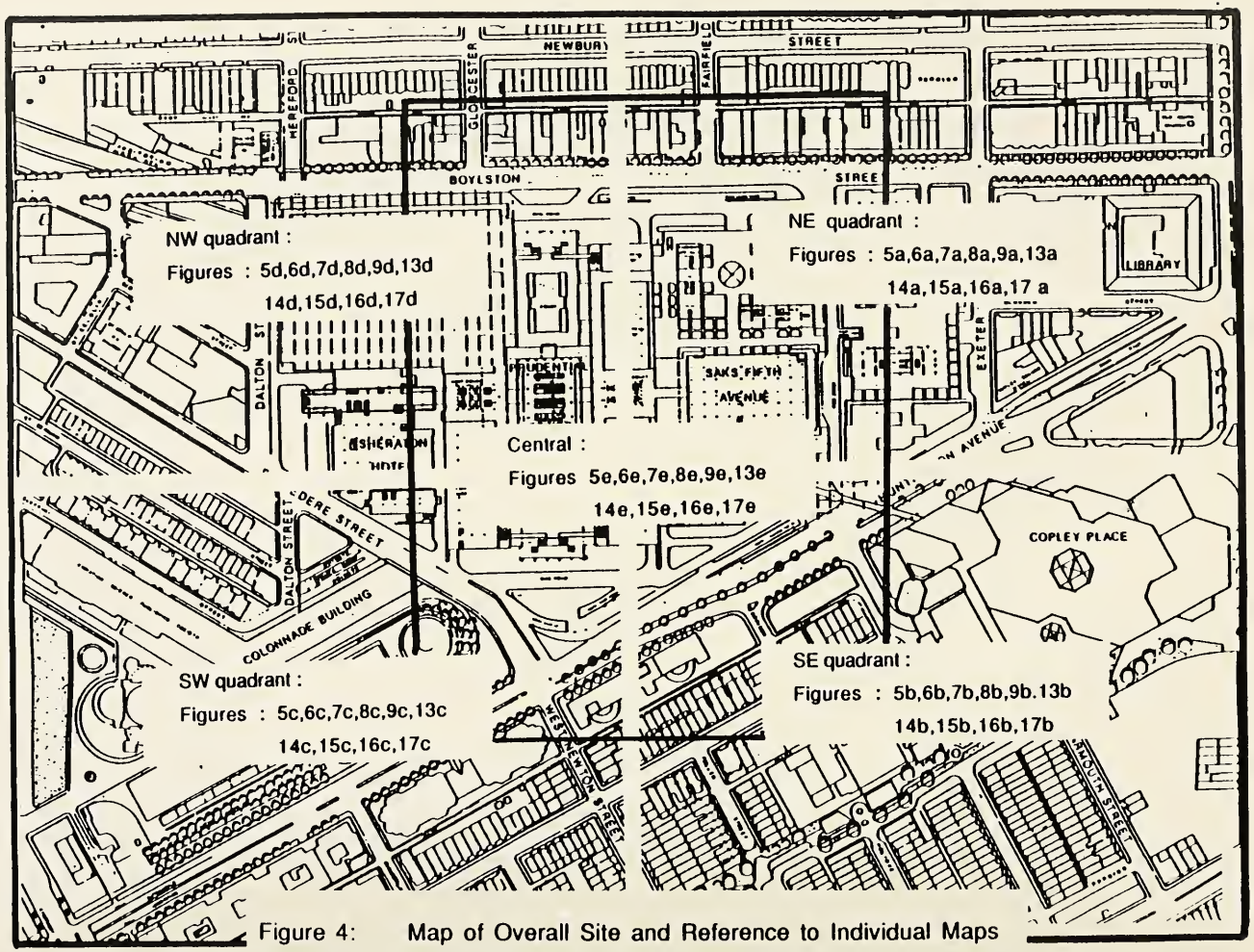
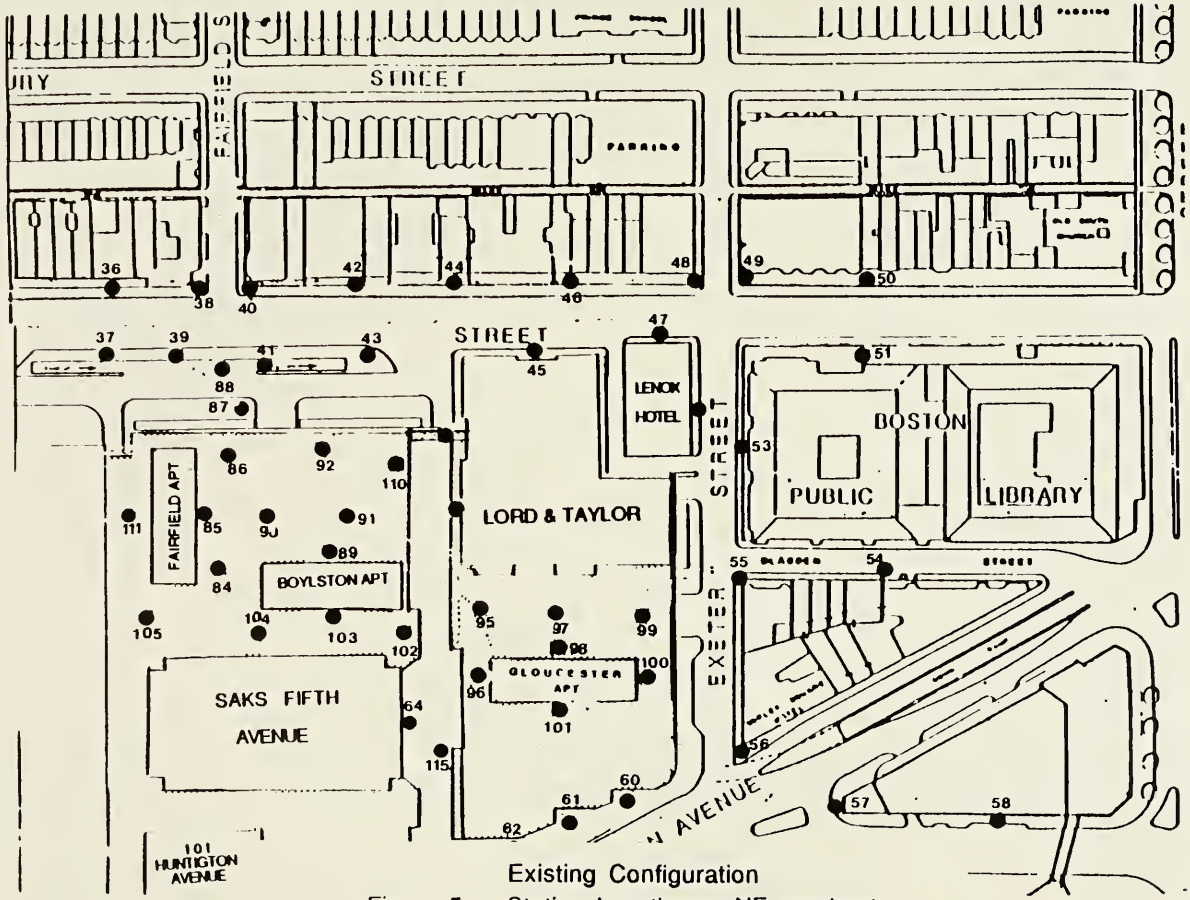
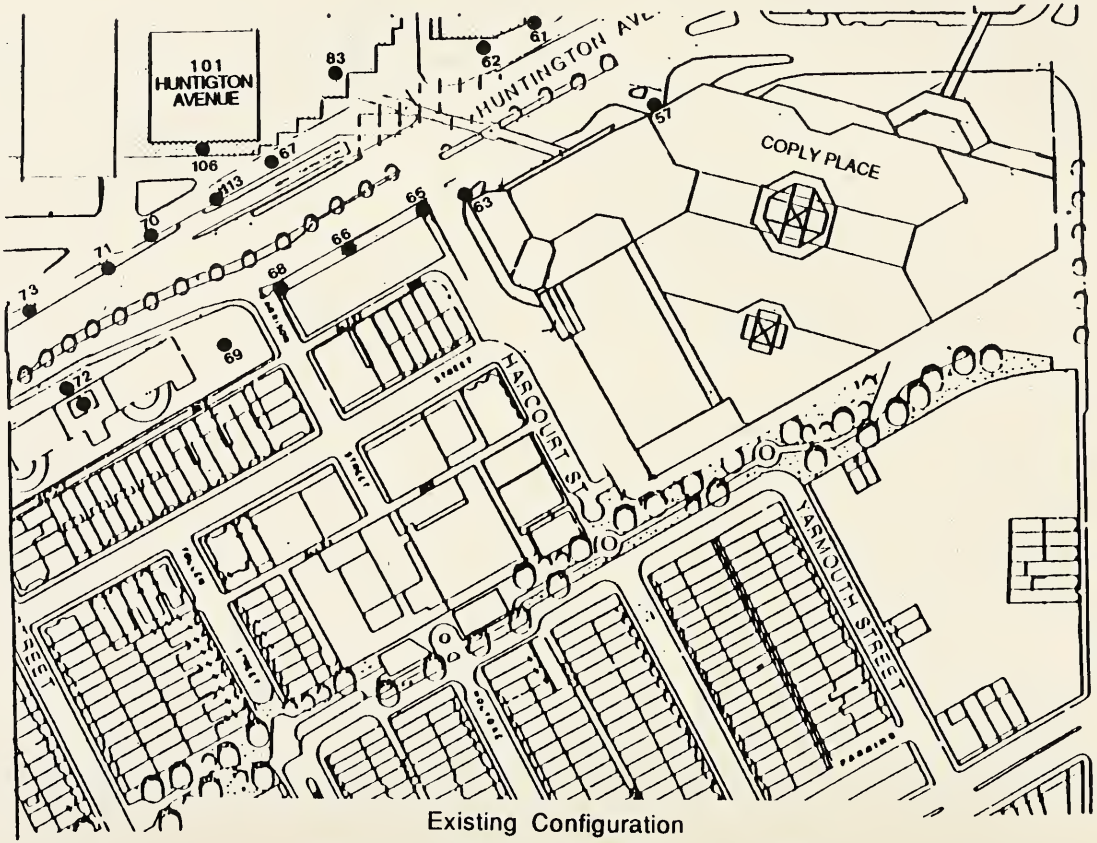


Figure 4: Map of Overall Site and Reference to Individual Maps



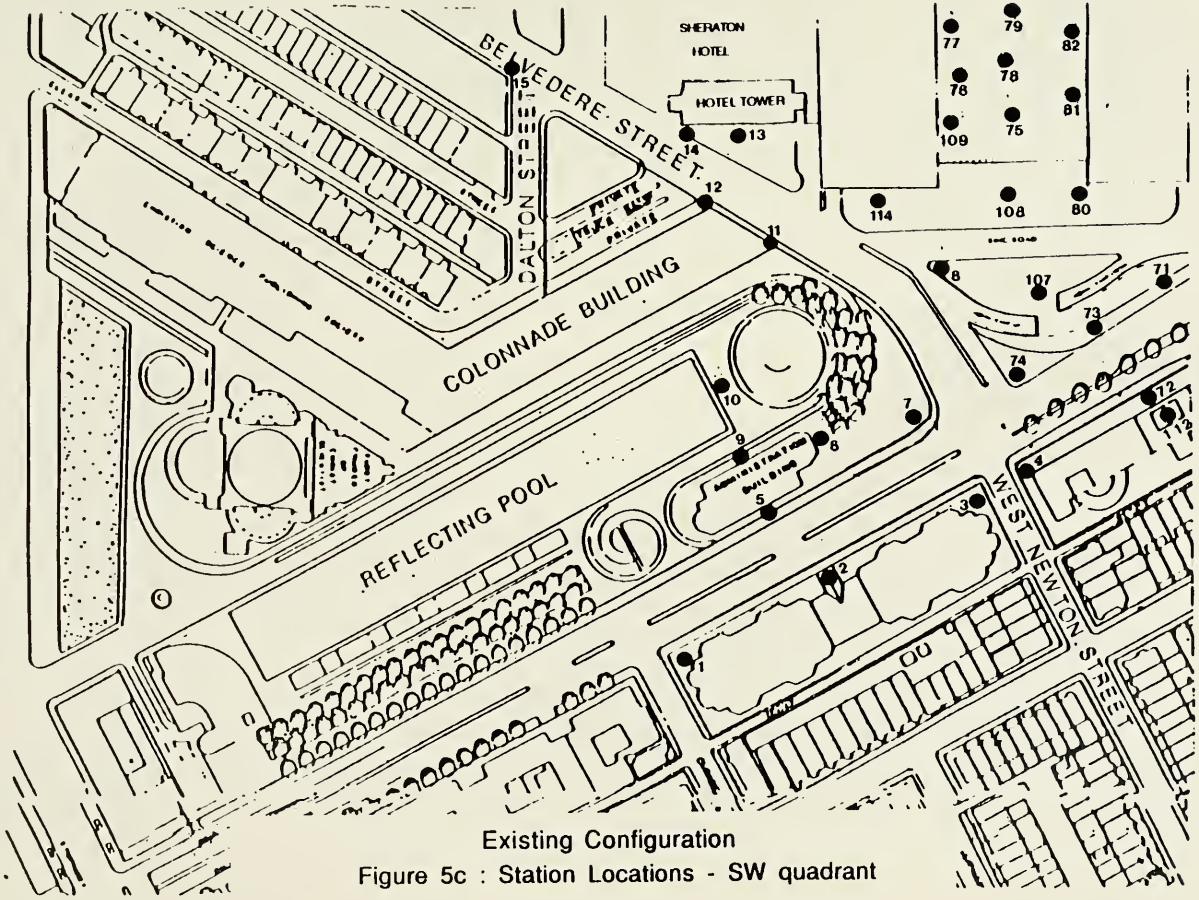
Existing Configuration

Figure 5a : Station Locations - NE quadrant



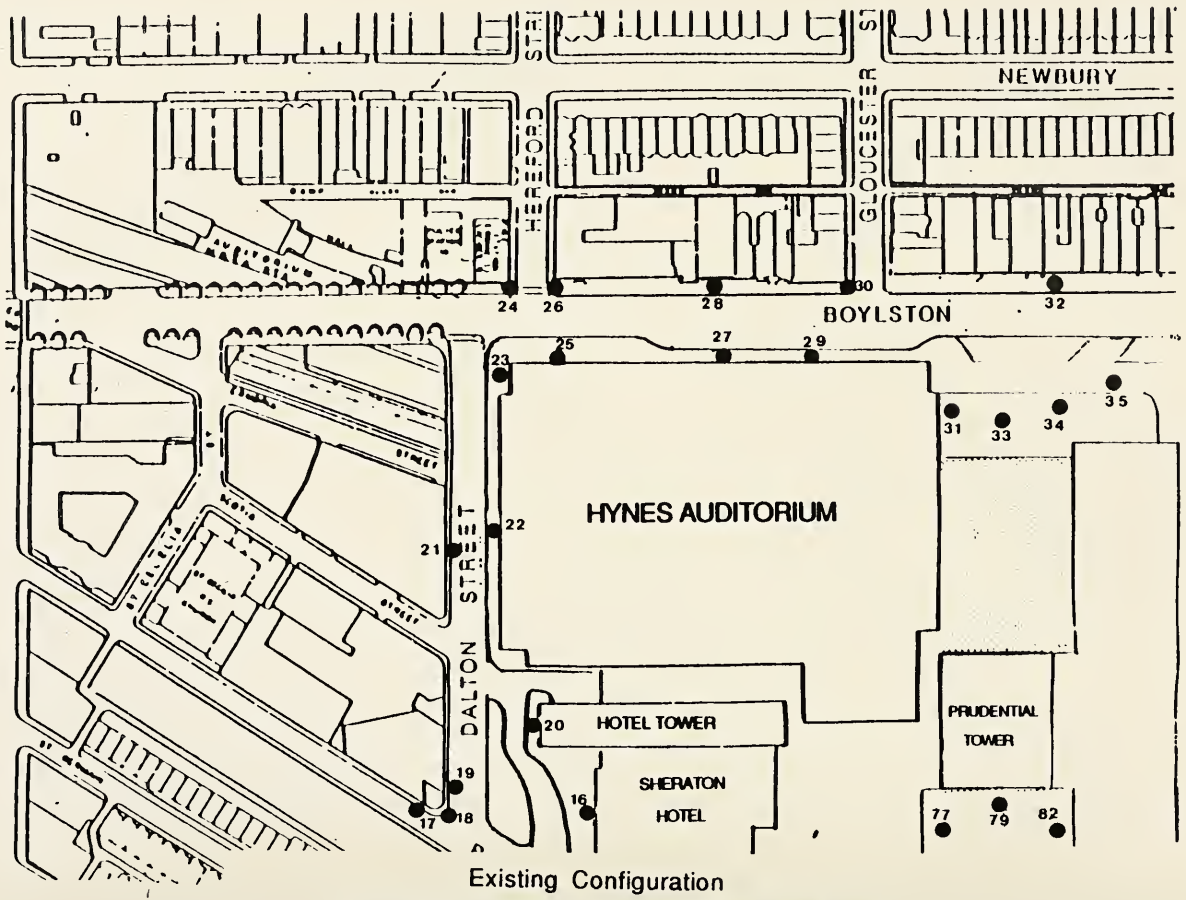
Existing Configuration

Figure 5b : Station Locations - SE quadrant



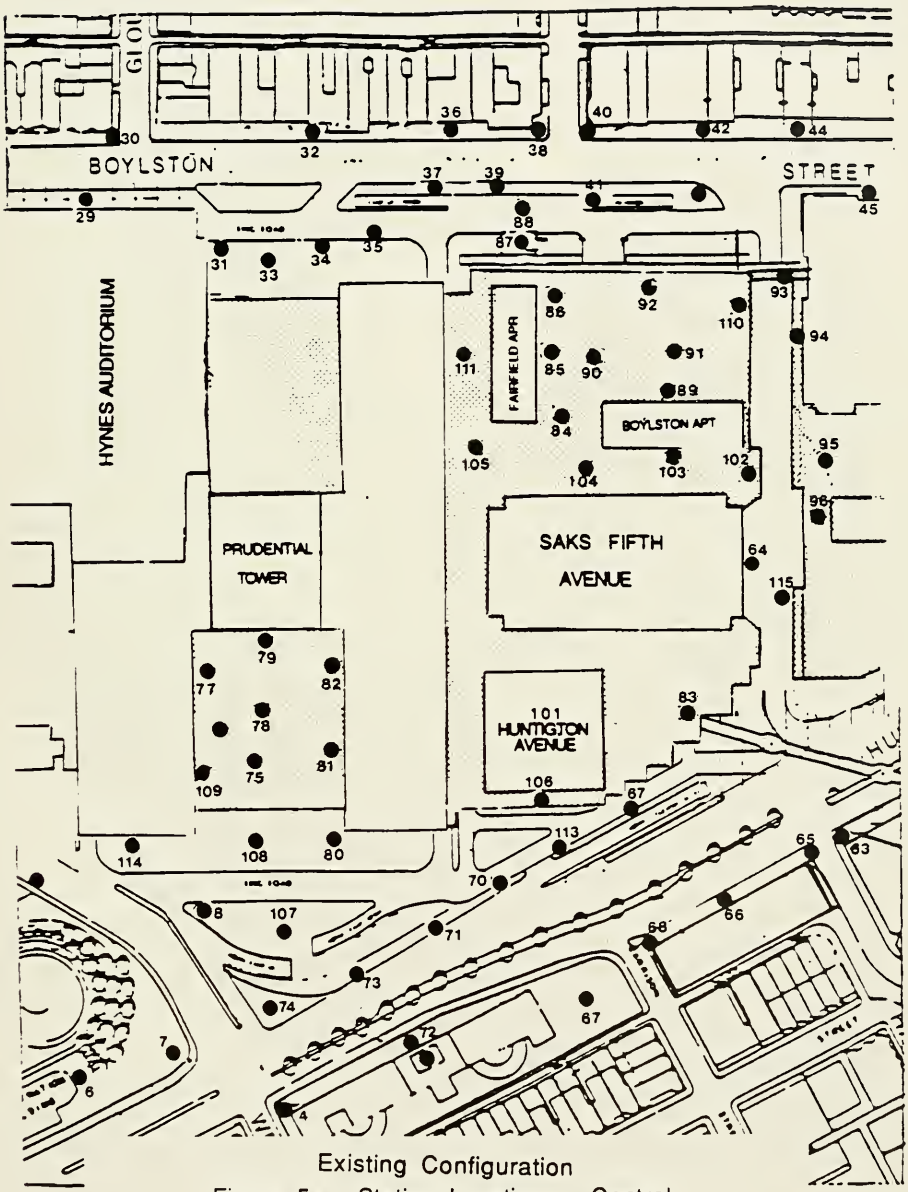
Existing Configuration

Figure 5c : Station Locations - SW quadrant



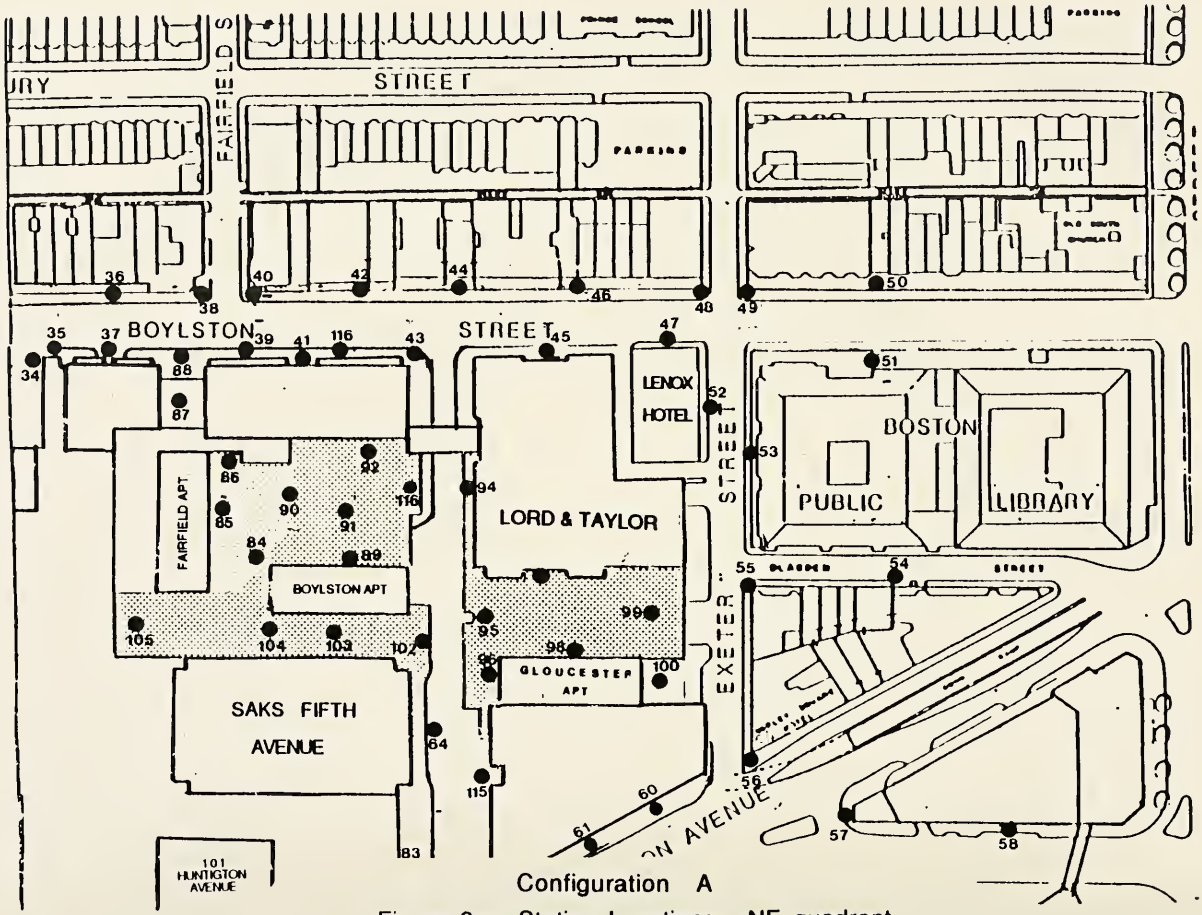
Existing Configuration

Figure 5d : Station Locations - NW quadrant



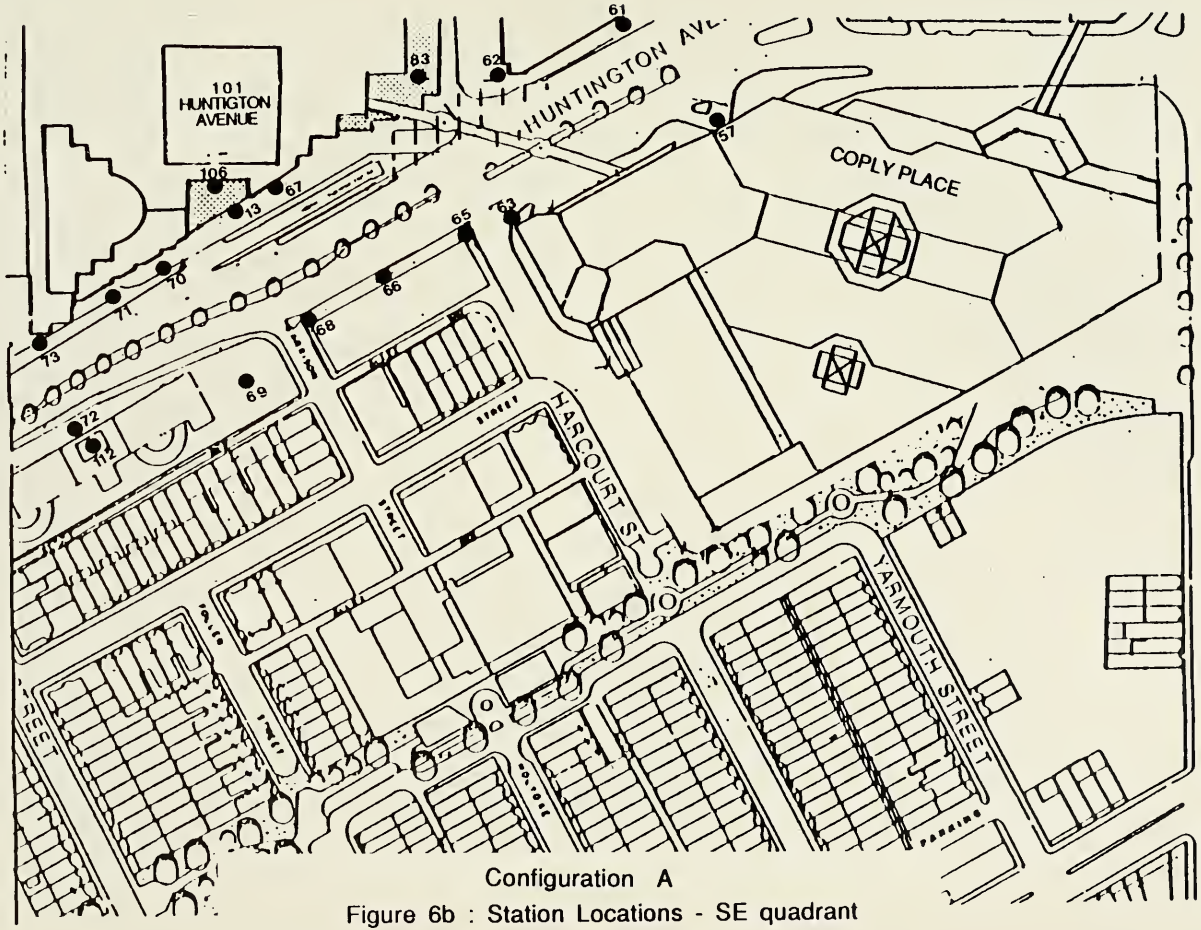
Existing Configuration

Figure 5e : Station Locations - Central



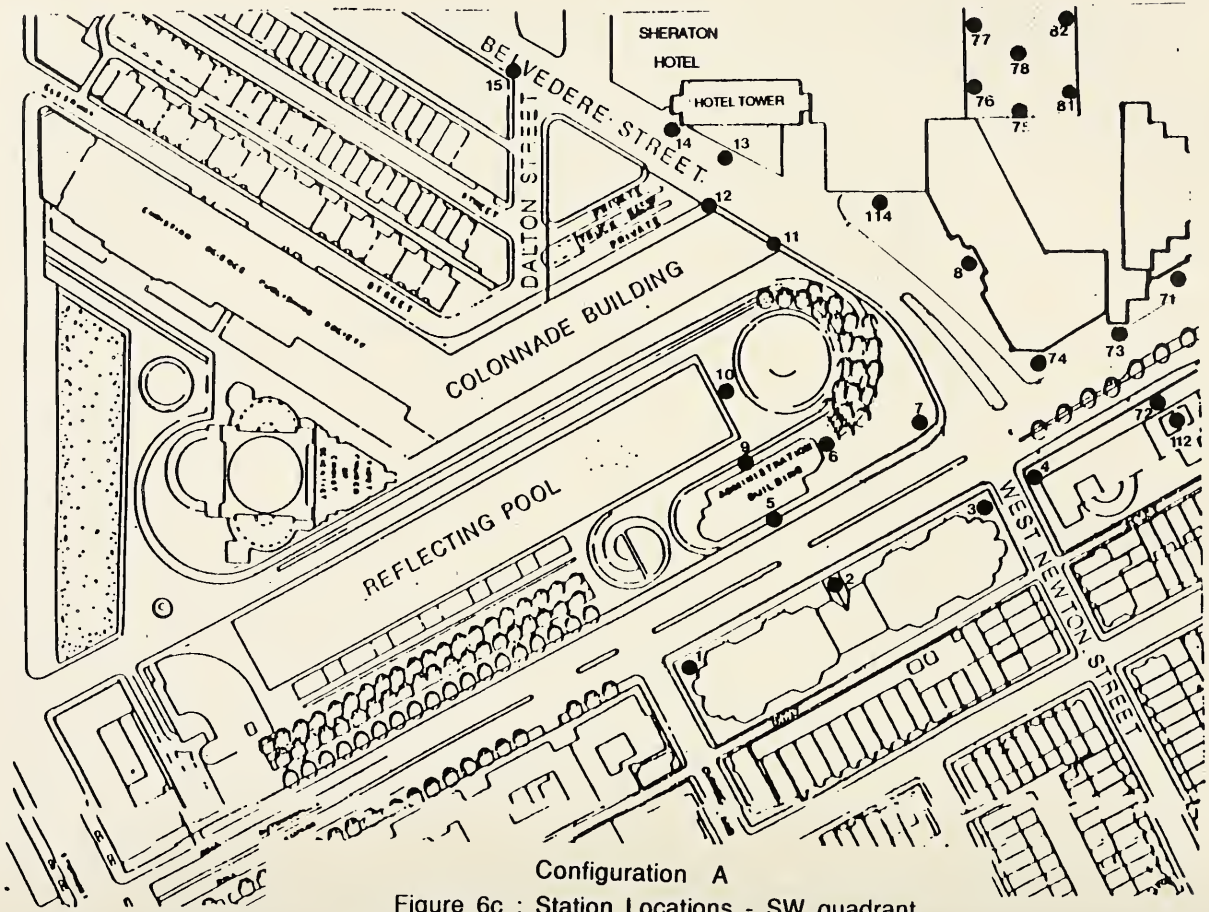
Configuration A

Figure 6a : Station Locations - NE quadrant



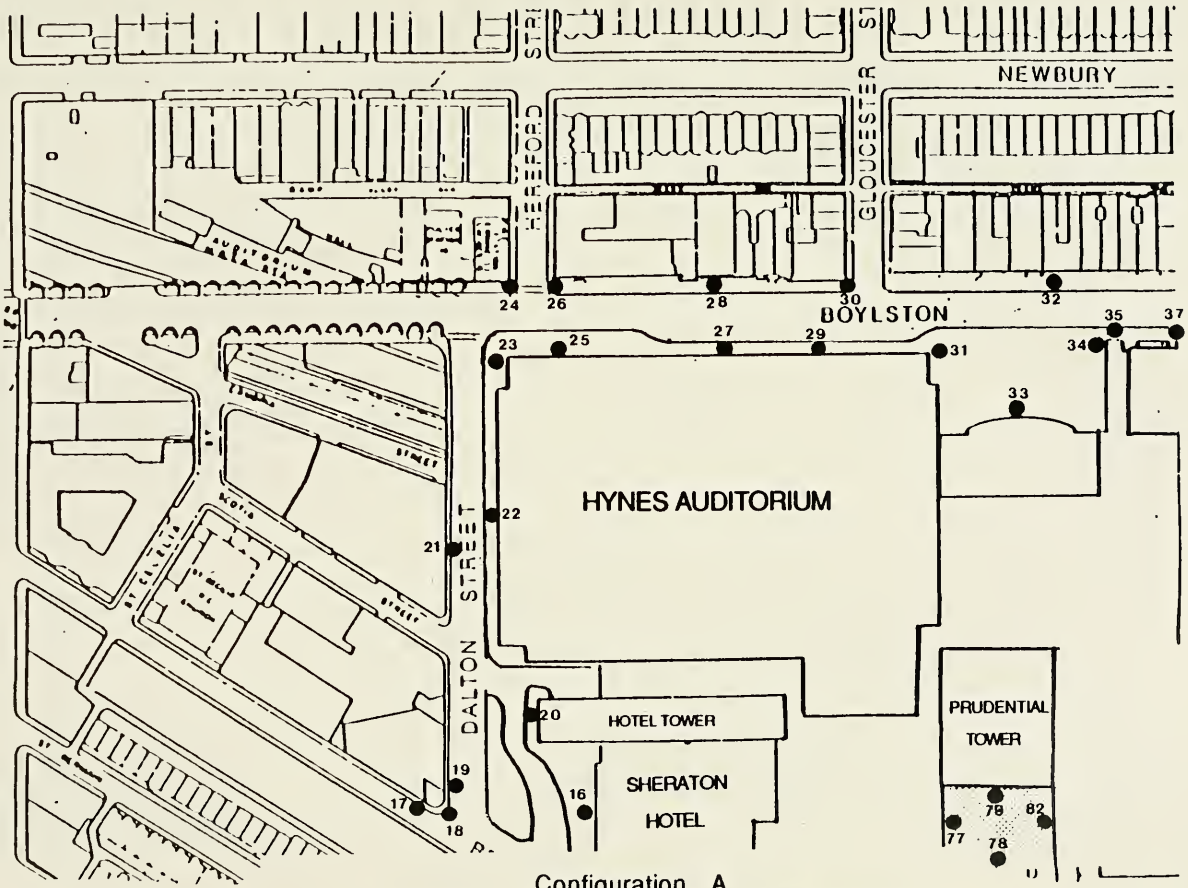
Configuration A

Figure 6b : Station Locations - SE quadrant



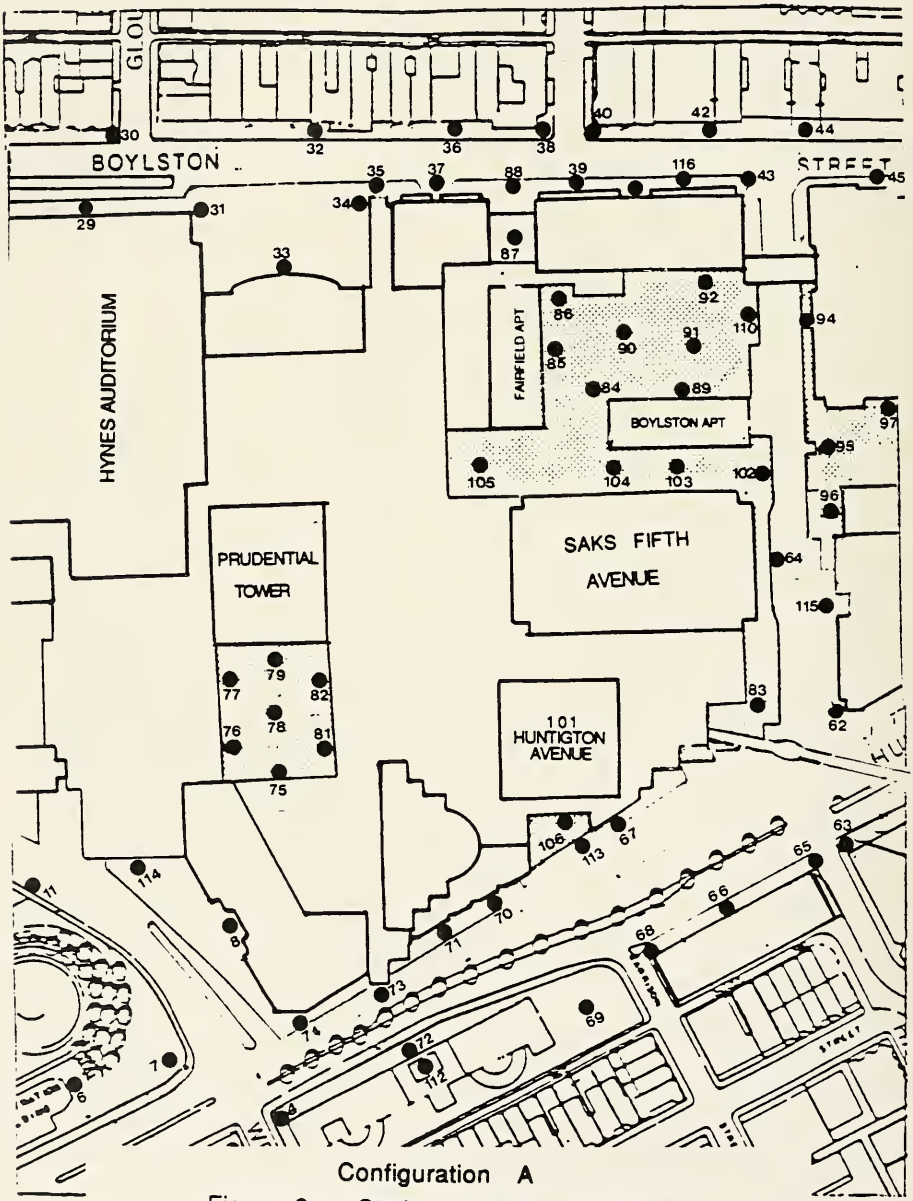
Configuration A

Figure 6c : Station Locations - SW quadrant



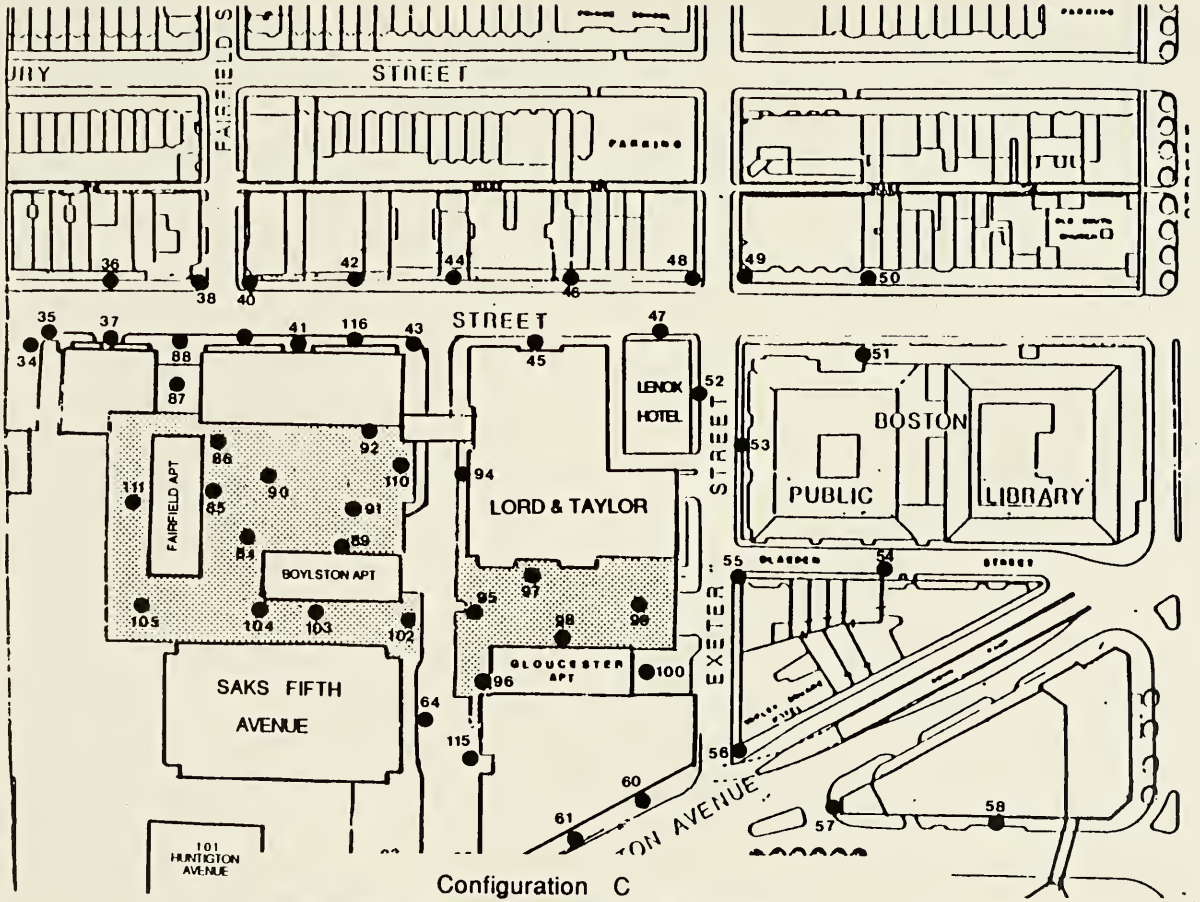
Configuration A

Figure 6d : Station Locations - NW quadrant



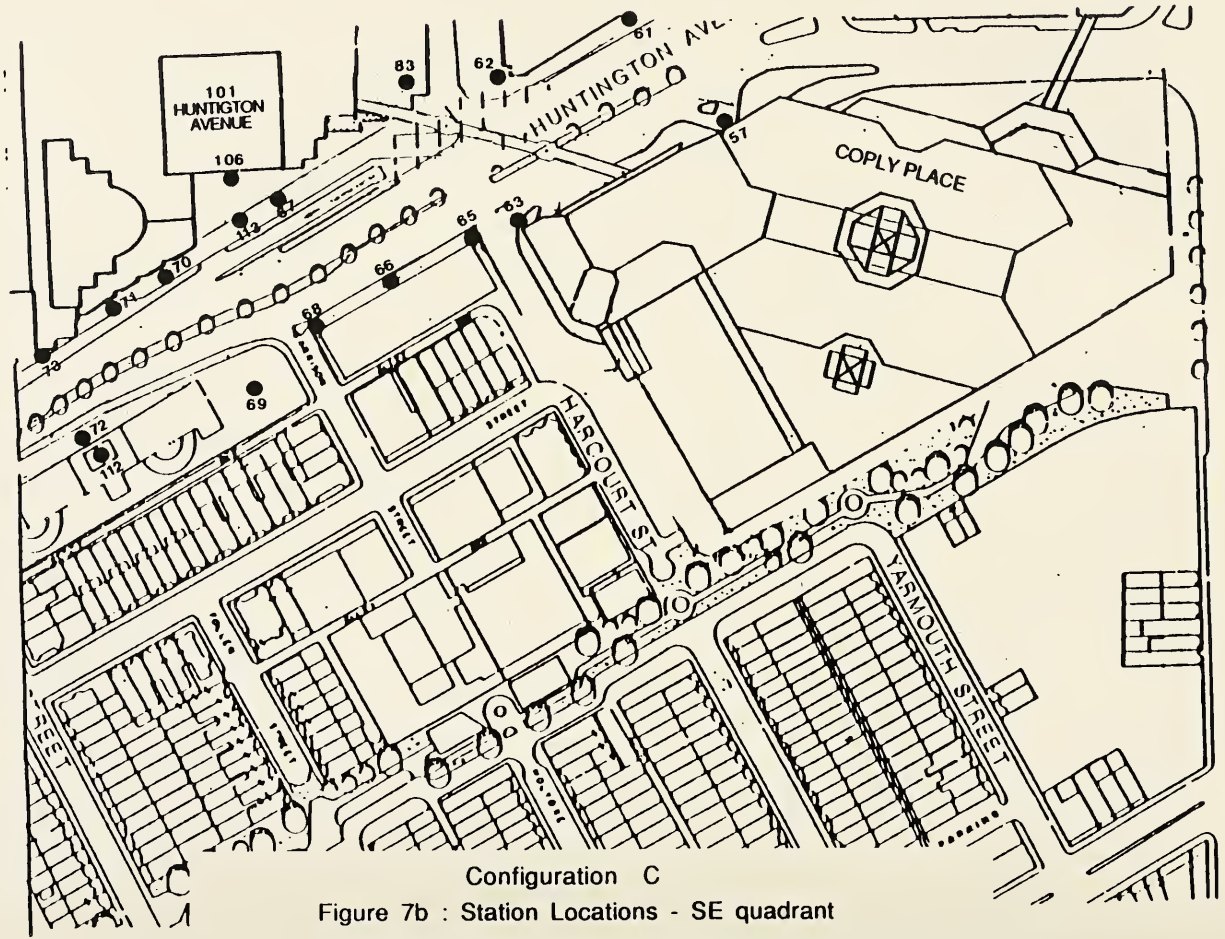
Configuration A

Figure 6e : Station Locations - Central



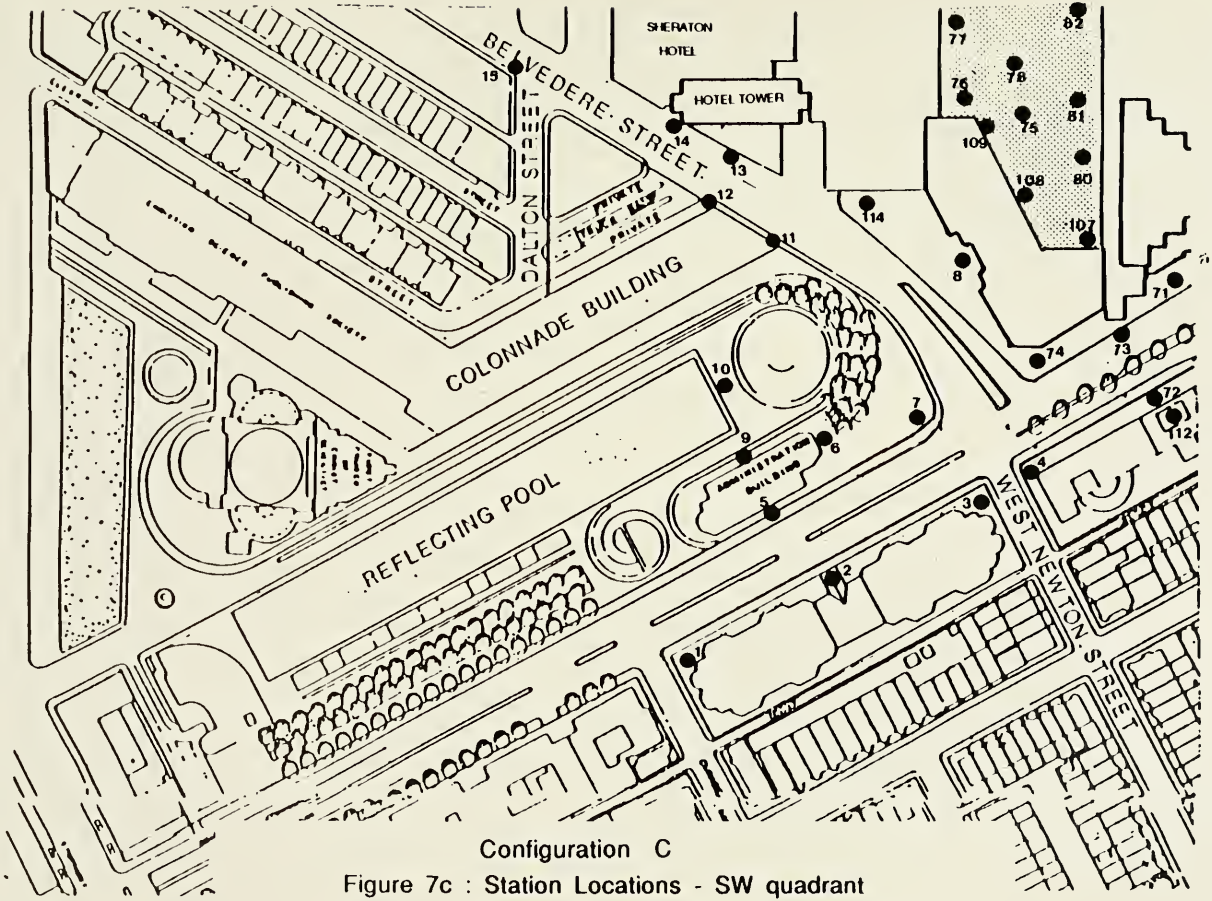
Configuration C

Figure 7a : Station Locations - NE quadrant



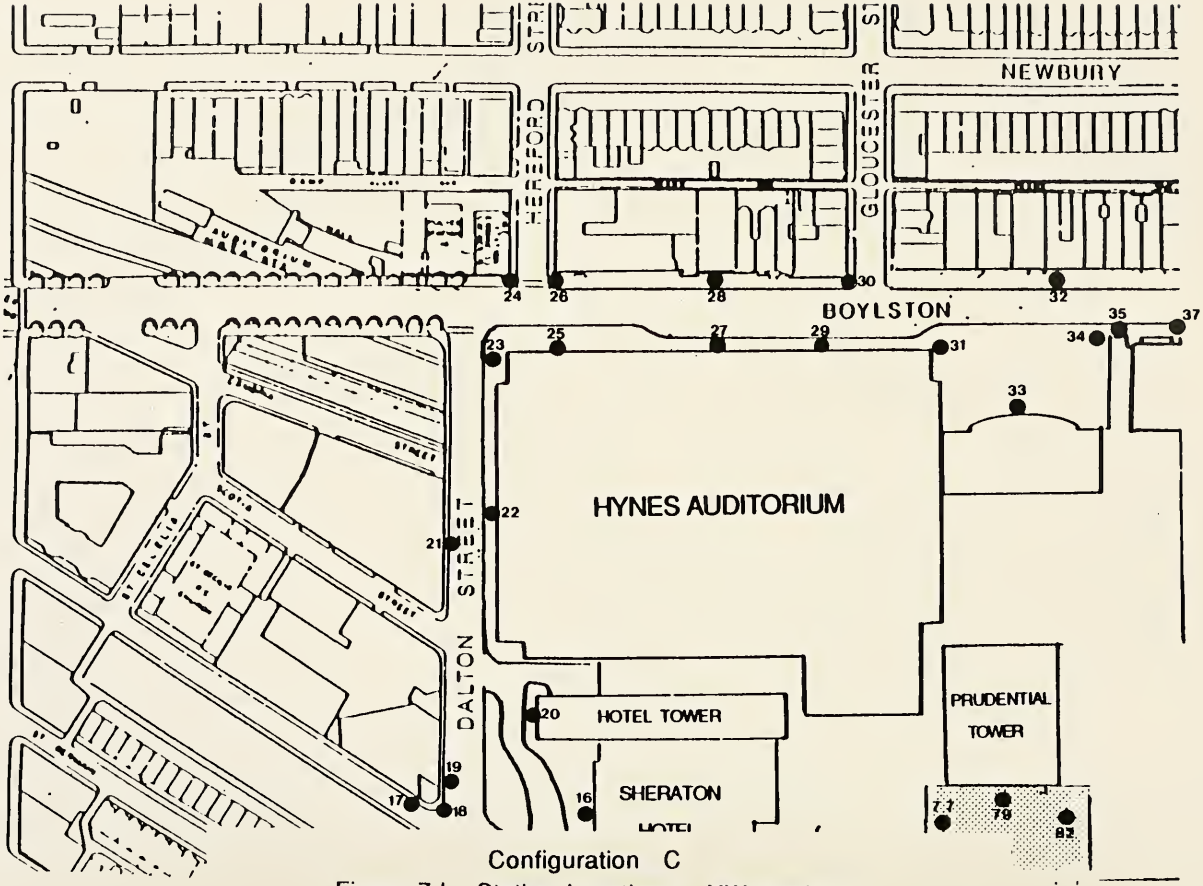
Configuration C

Figure 7b : Station Locations - SE quadrant



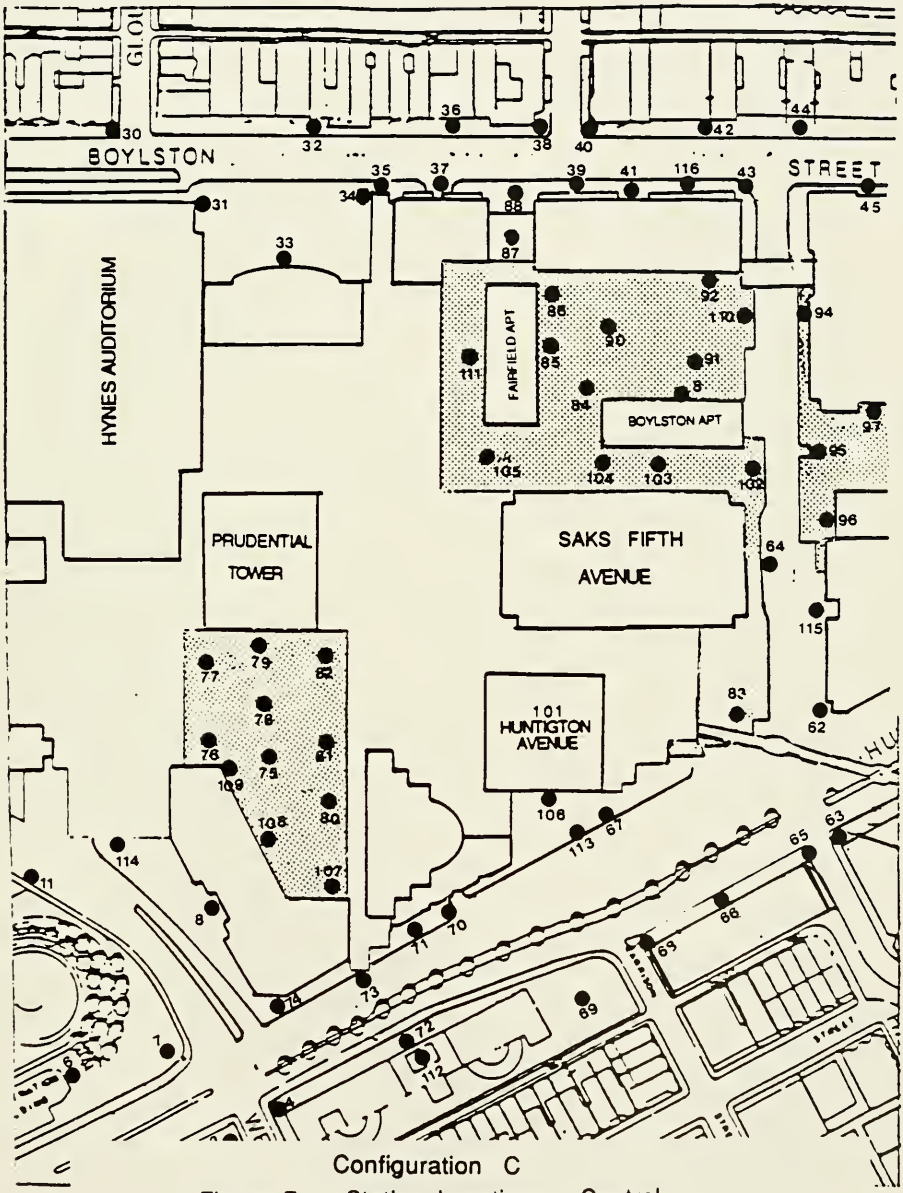
Configuration C

Figure 7c : Station Locations - SW quadrant



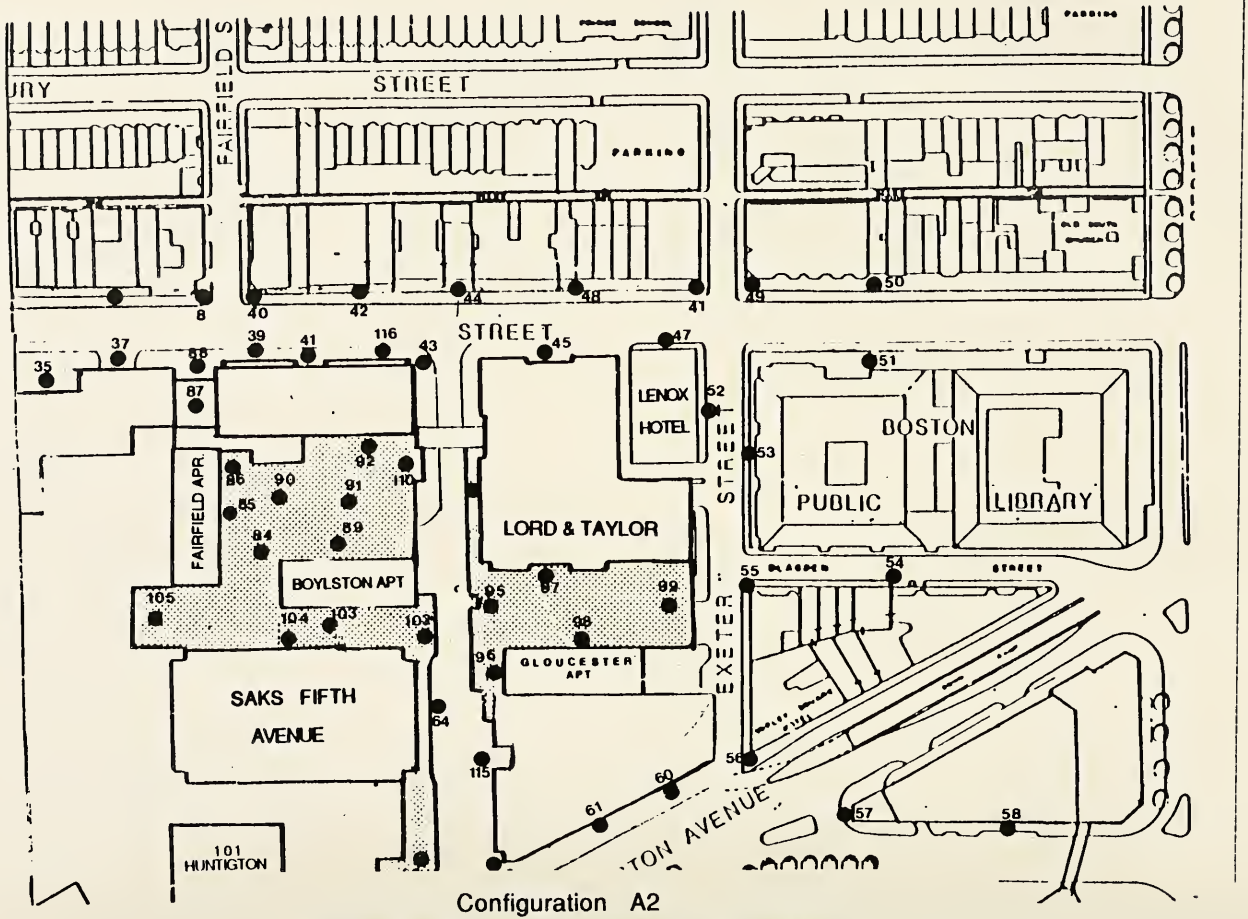
Configuration C

Figure 7d : Station Locations - NW quadrant



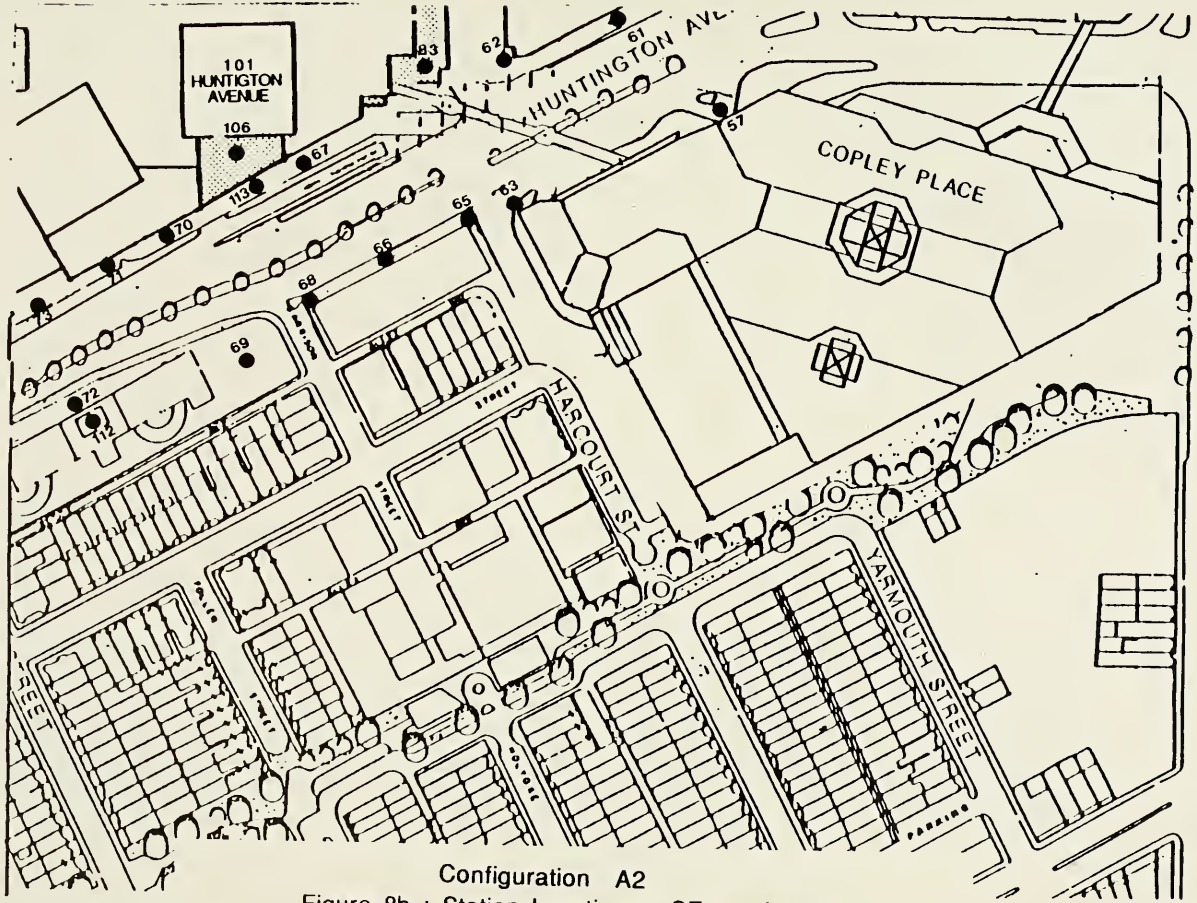
Configuration C

Figure 7e : Station Locations - Central



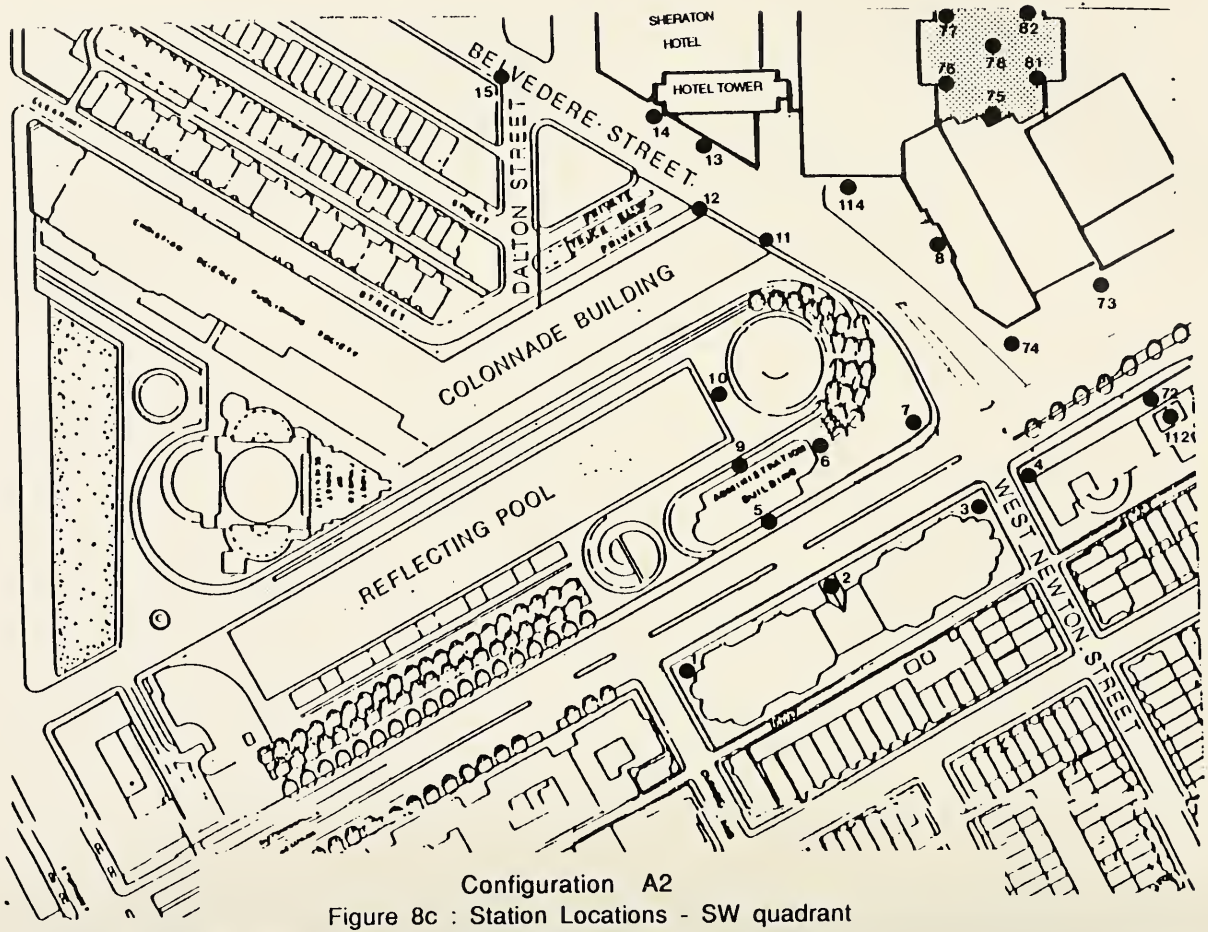
Configuration A2

Figure 8a : Station Locations - NE quadrant



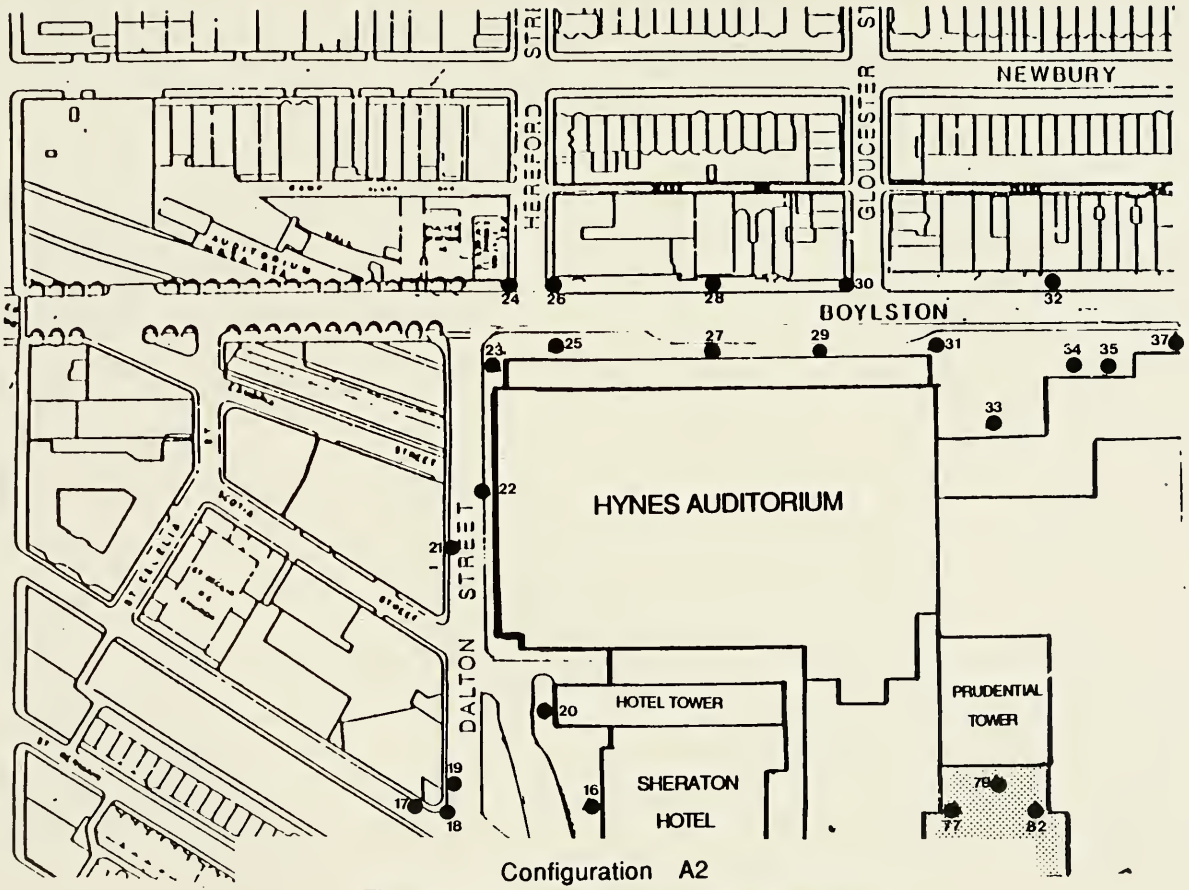
Configuration A2

Figure 8b : Station Locations - SE quadrant



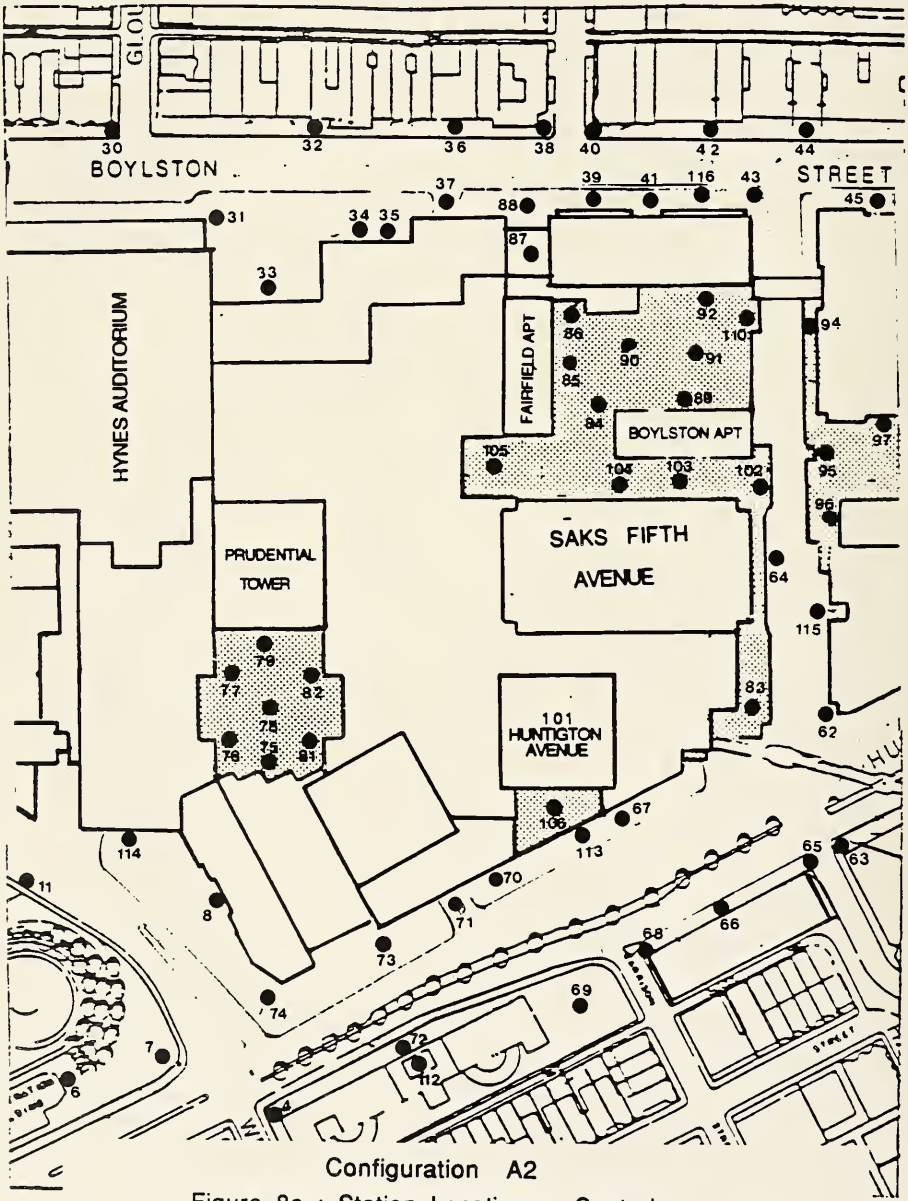
Configuration A2

Figure 8c : Station Locations - SW quadrant



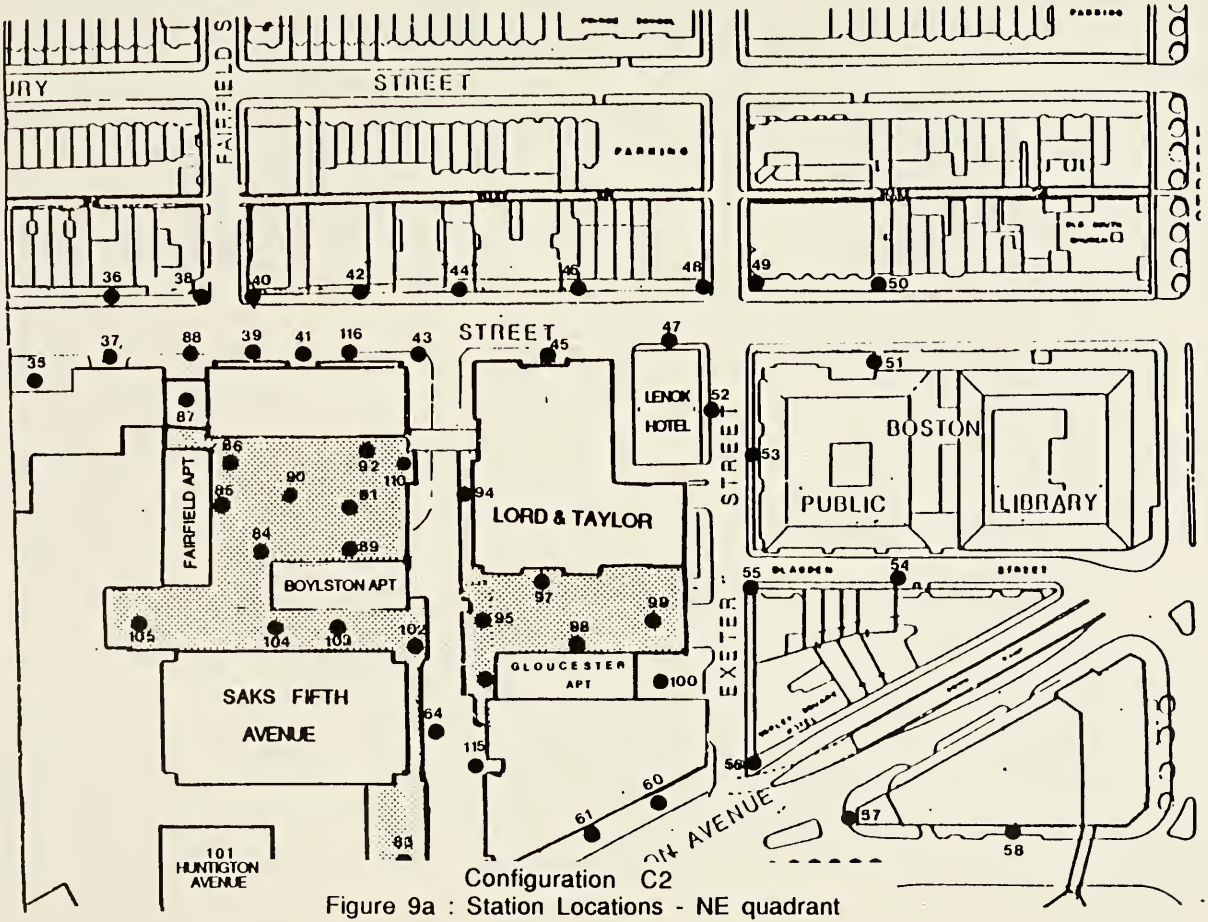
Configuration A2

Figure 8d : Station Locations - NW quadrant



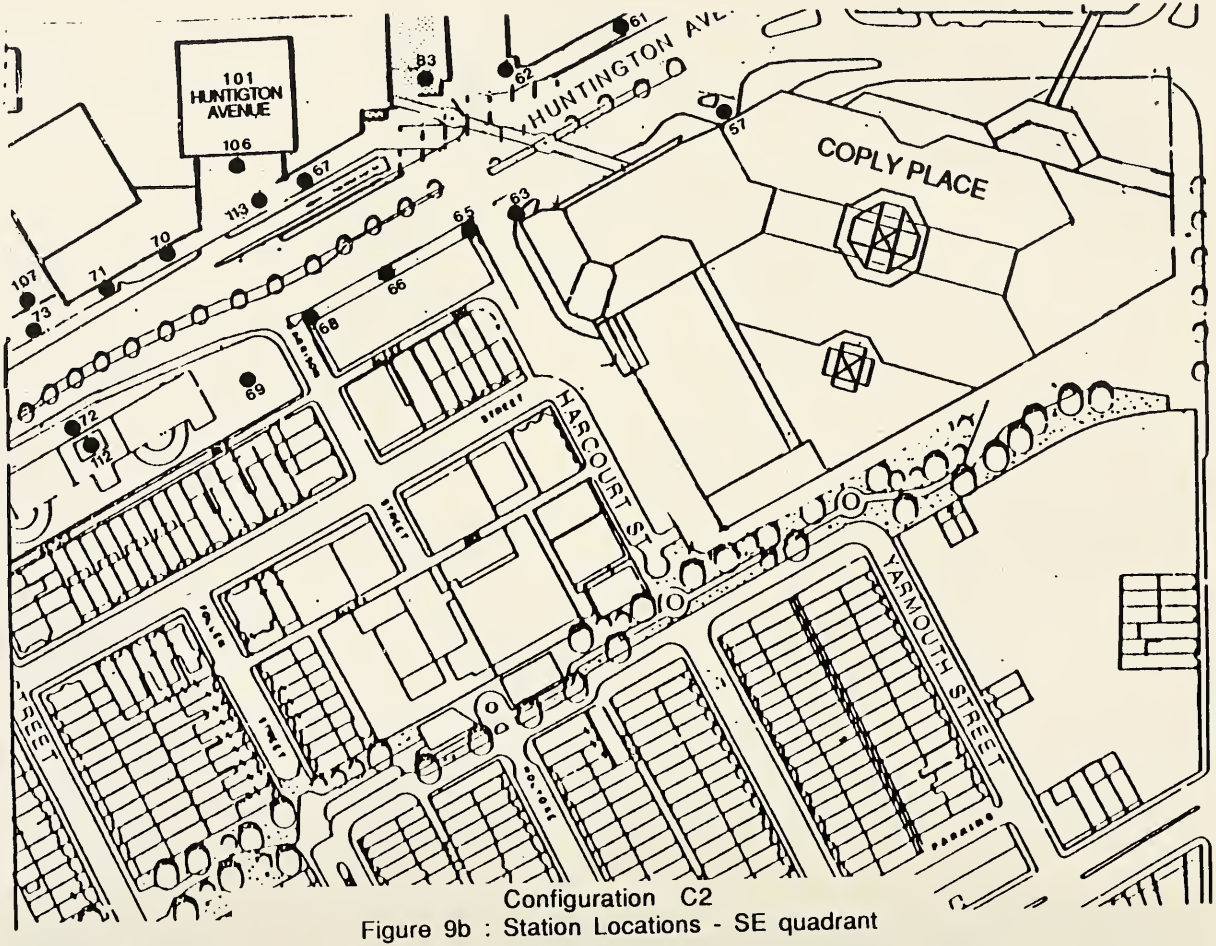
Configuration A2

Figure 8e : Station Locations - Central



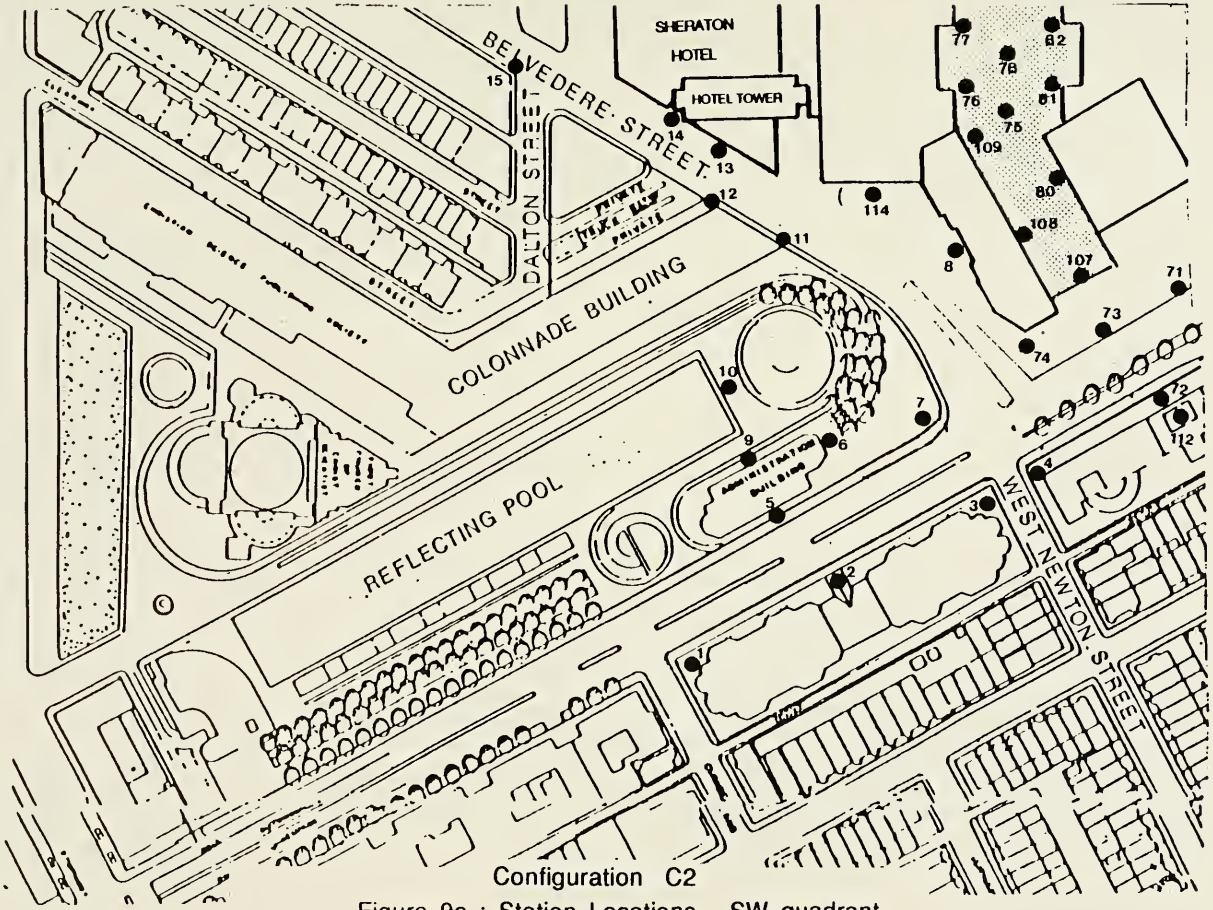
Configuration C2

Figure 9a : Station Locations - NE quadrant



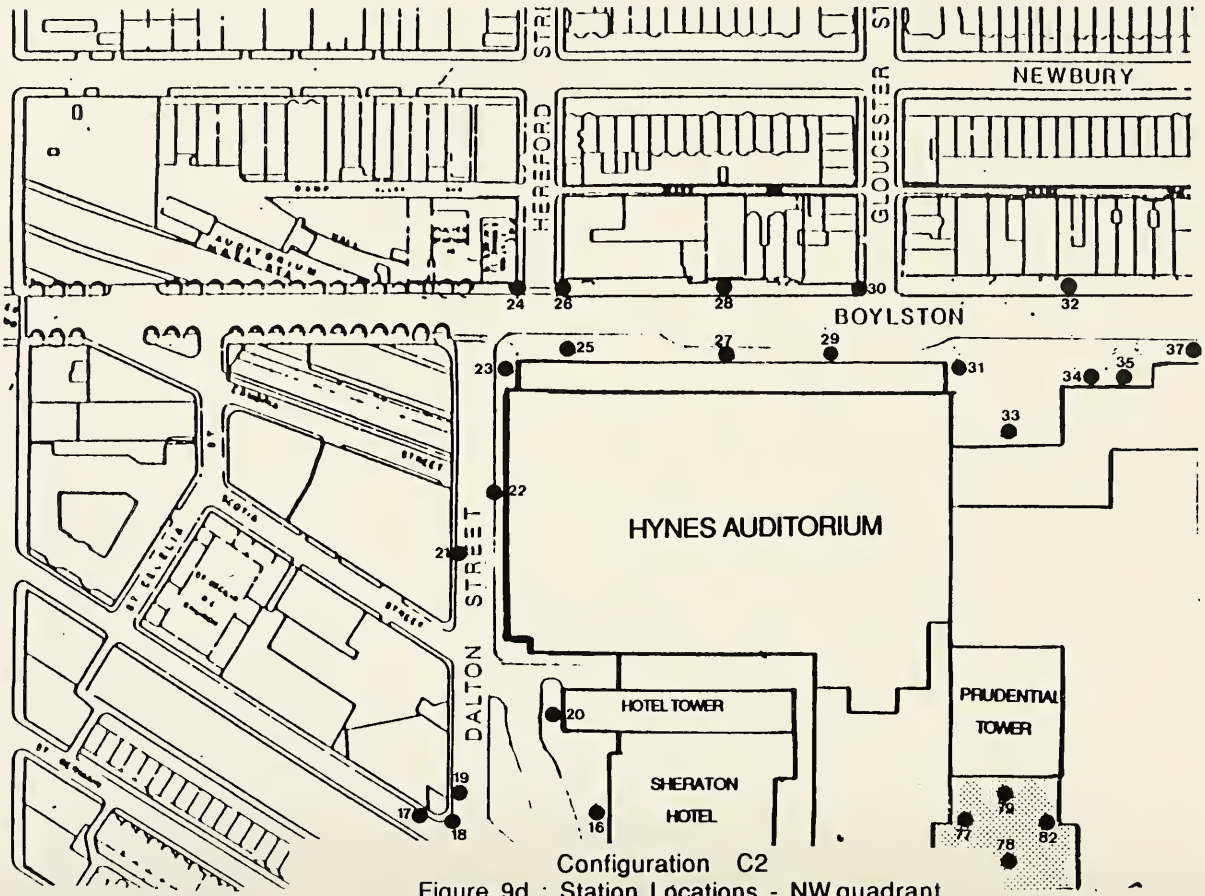
Configuration C2

Figure 9b : Station Locations - SE quadrant



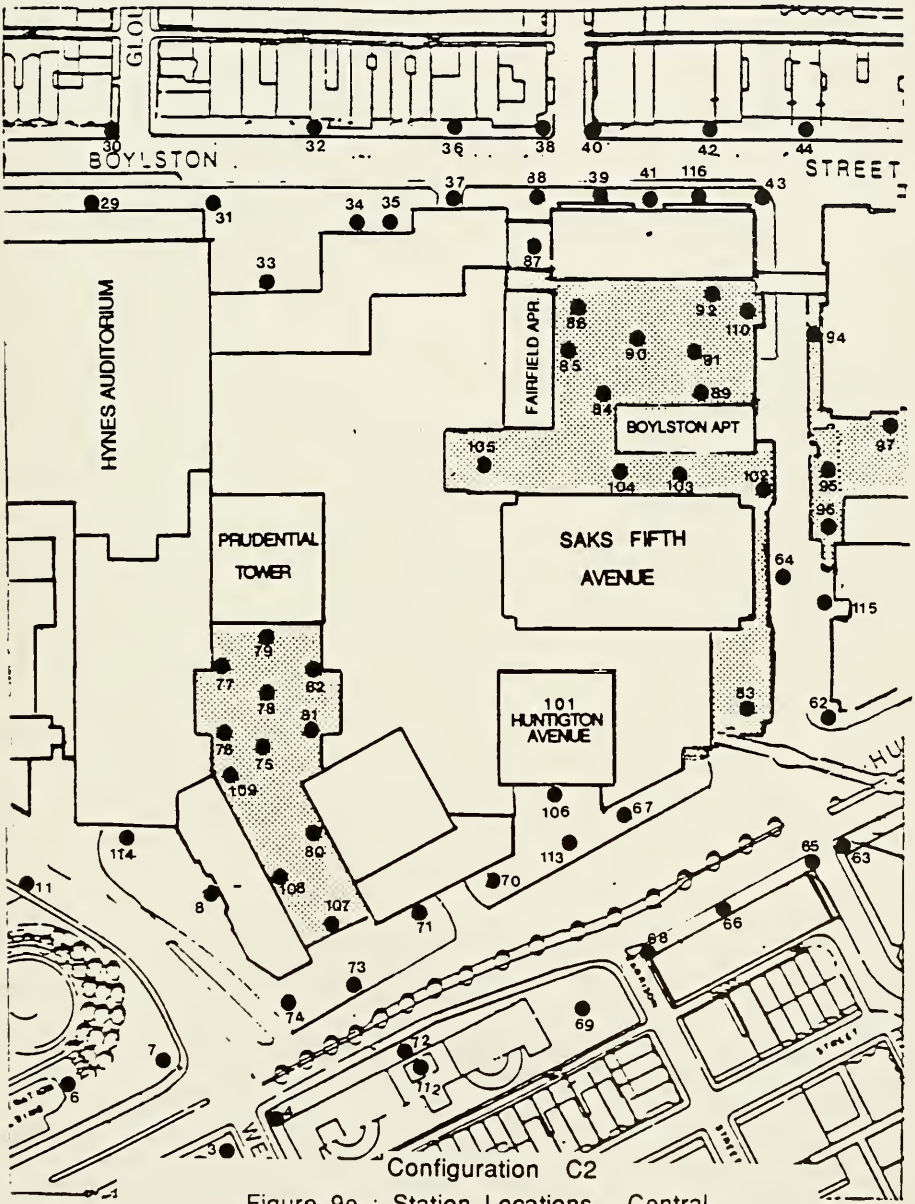
Configuration C2

Figure 9c : Station Locations - SW quadrant



Configuration C2

Figure 9d : Station Locations - NW quadrant



Configuration C2

Figure 9e : Station Locations - Central

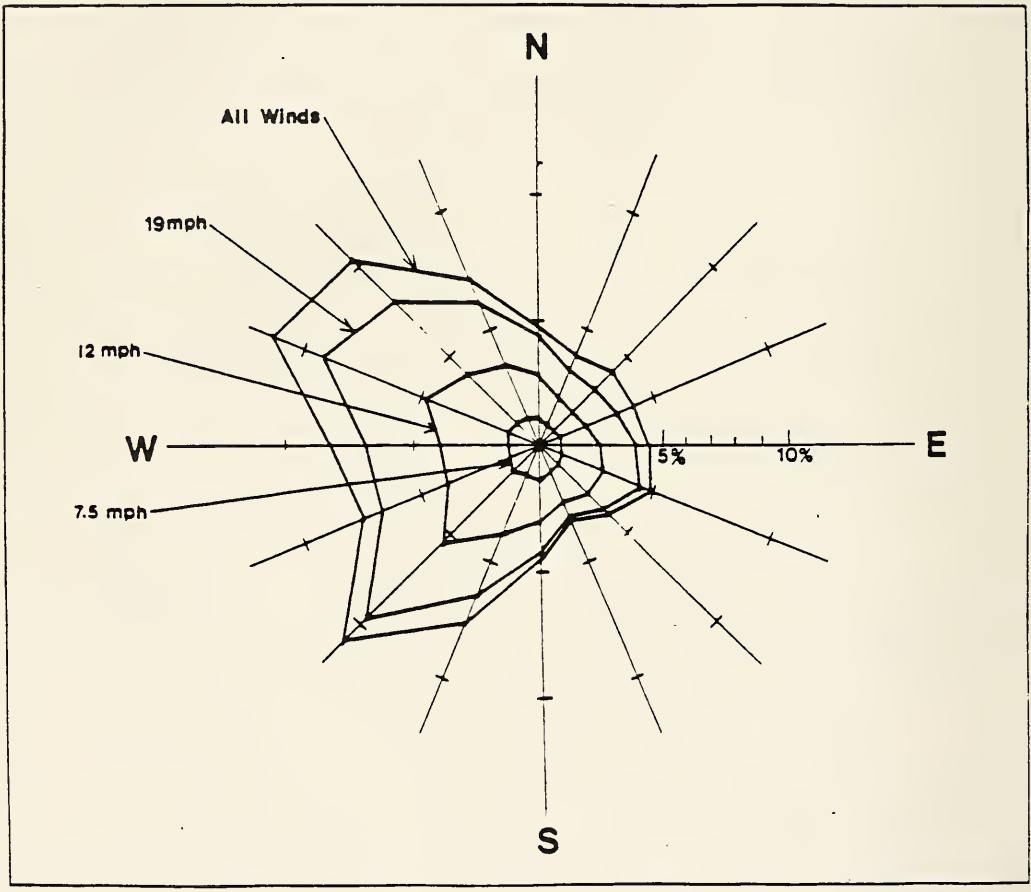


Figure 10. Boston Annual Wind Rose - Surface Data Obtained from Logan Airport: 1945-1965

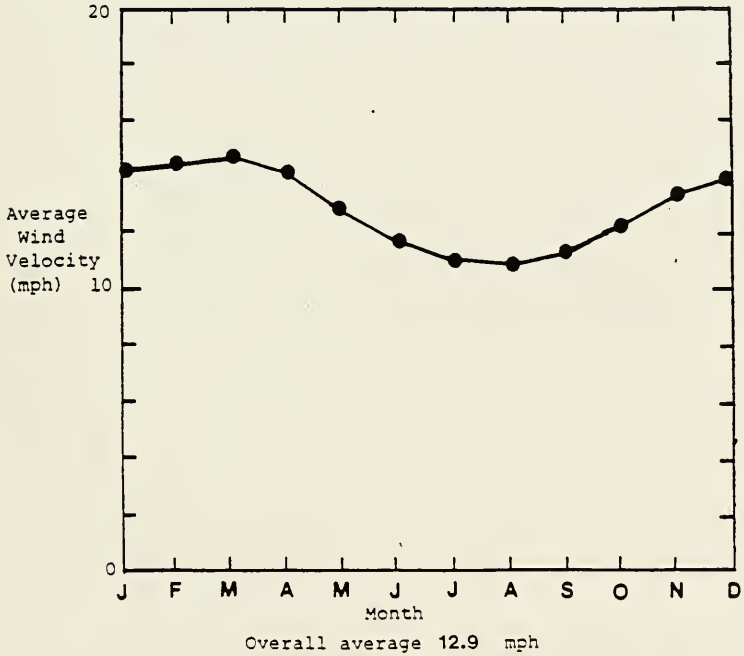
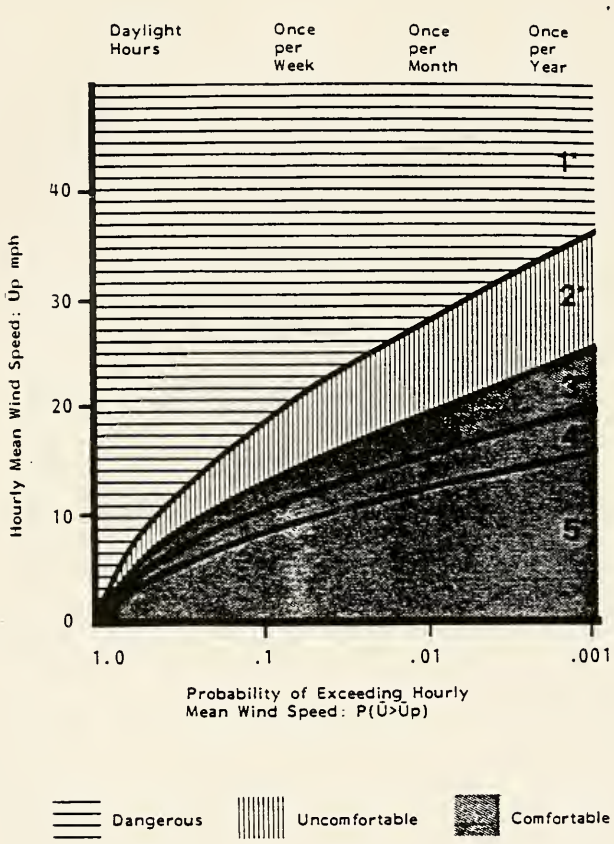


Figure 11. Average Wind Velocity at Logan Airport at 58 Feet: 1945-1965 by Month



*Melbourne's Category

1 Unacceptable and dangerous
2 Uncomfortable for walking
3 Acceptable for walking
4 Acceptable for short periods of standing or sitting
5 Acceptable for long periods of standing or sitting

Figure 12. Melbourne's Criteria for Equivalent Average Hourly Pedestrian Level Winds

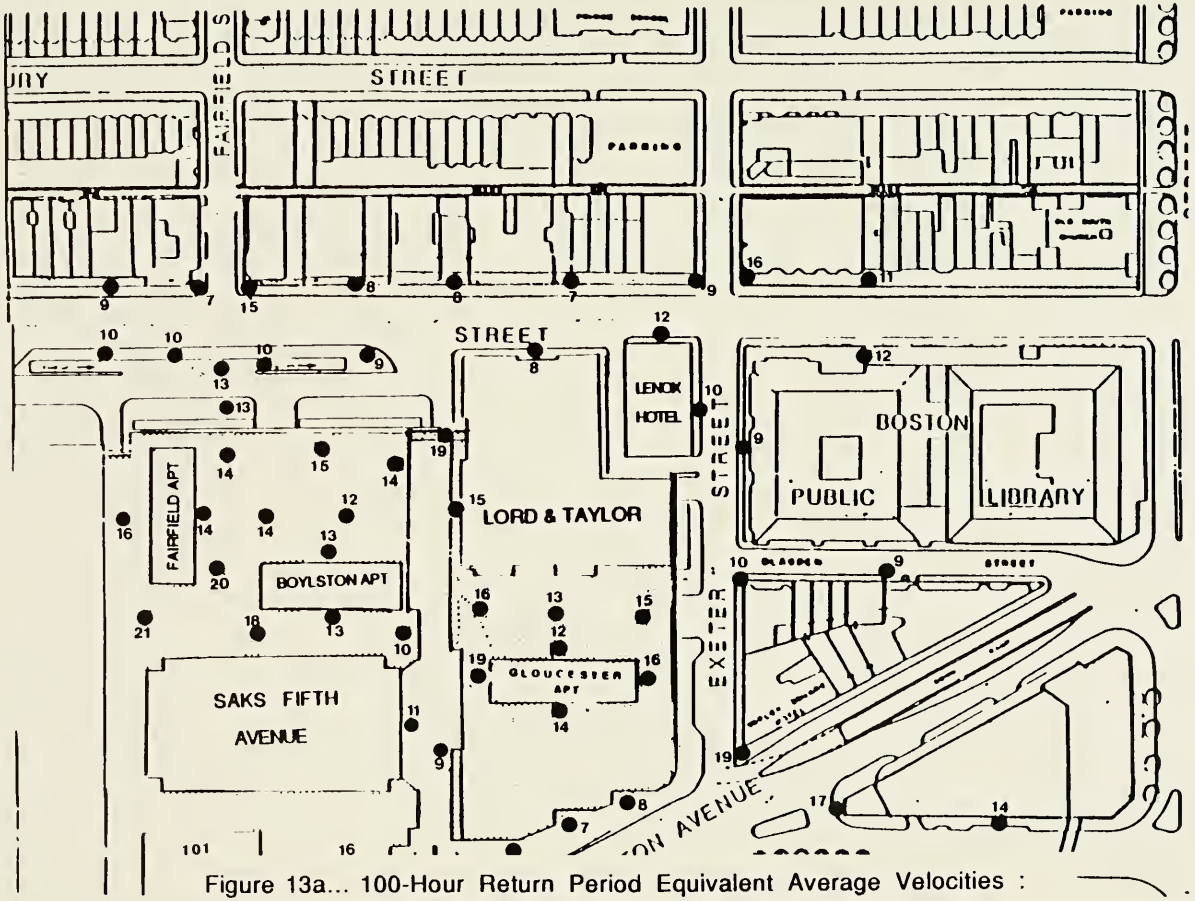


Figure 13a... 100-Hour Return Period Equivalent Average Velocities :
Existing Configuration - NE quadrant

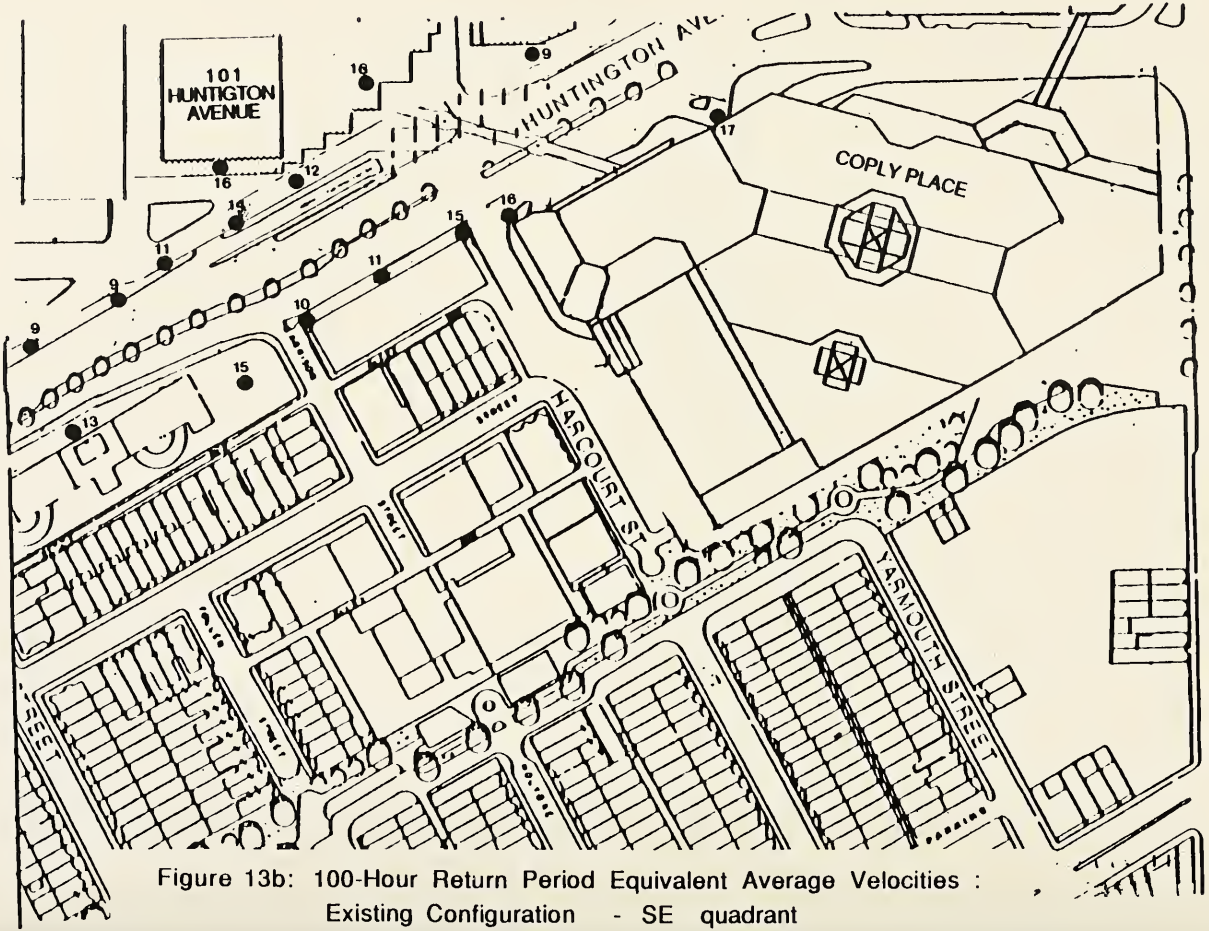


Figure 13b: 100-Hour Return Period Equivalent Average Velocities :
Existing Configuration - SE quadrant

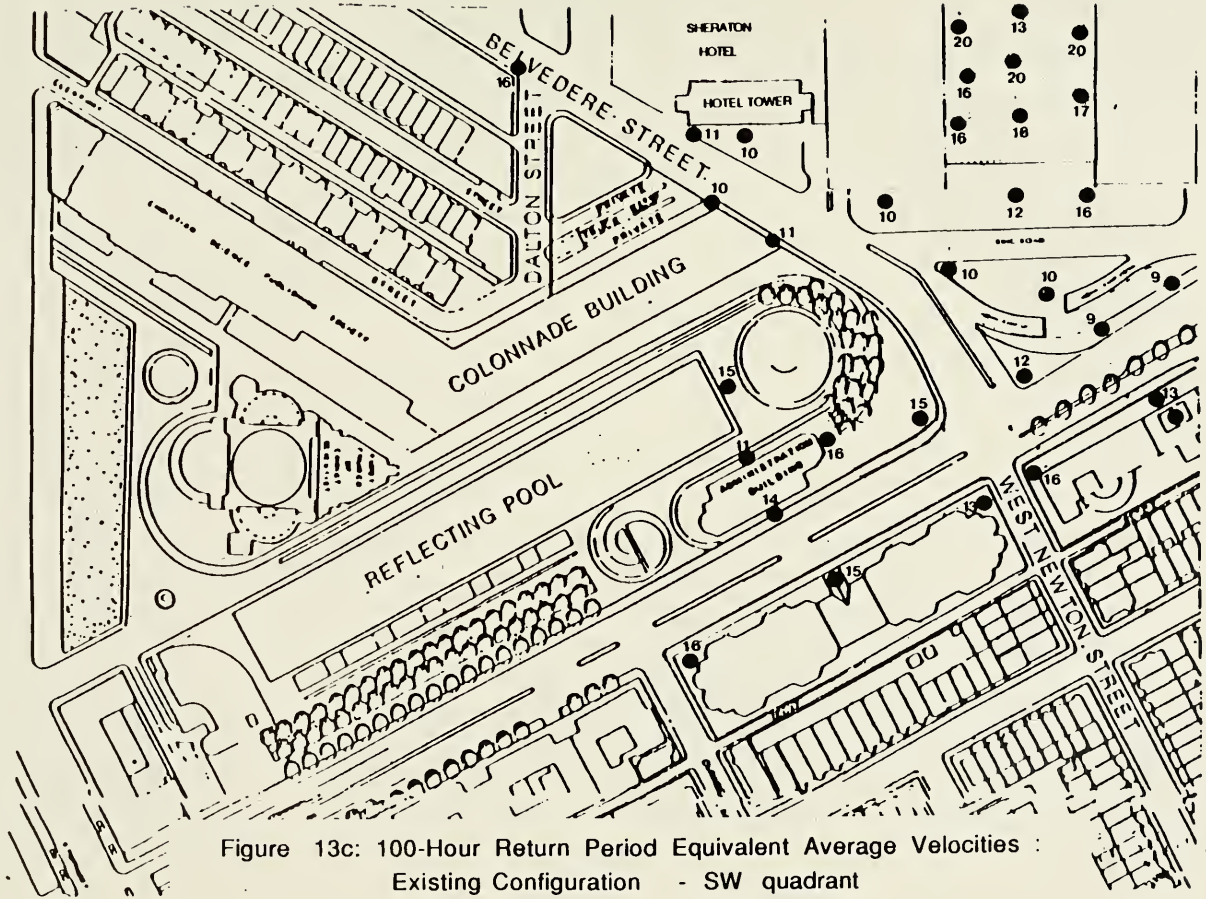


Figure 13c: 100-Hour Return Period Equivalent Average Velocities : Existing Configuration - SW quadrant

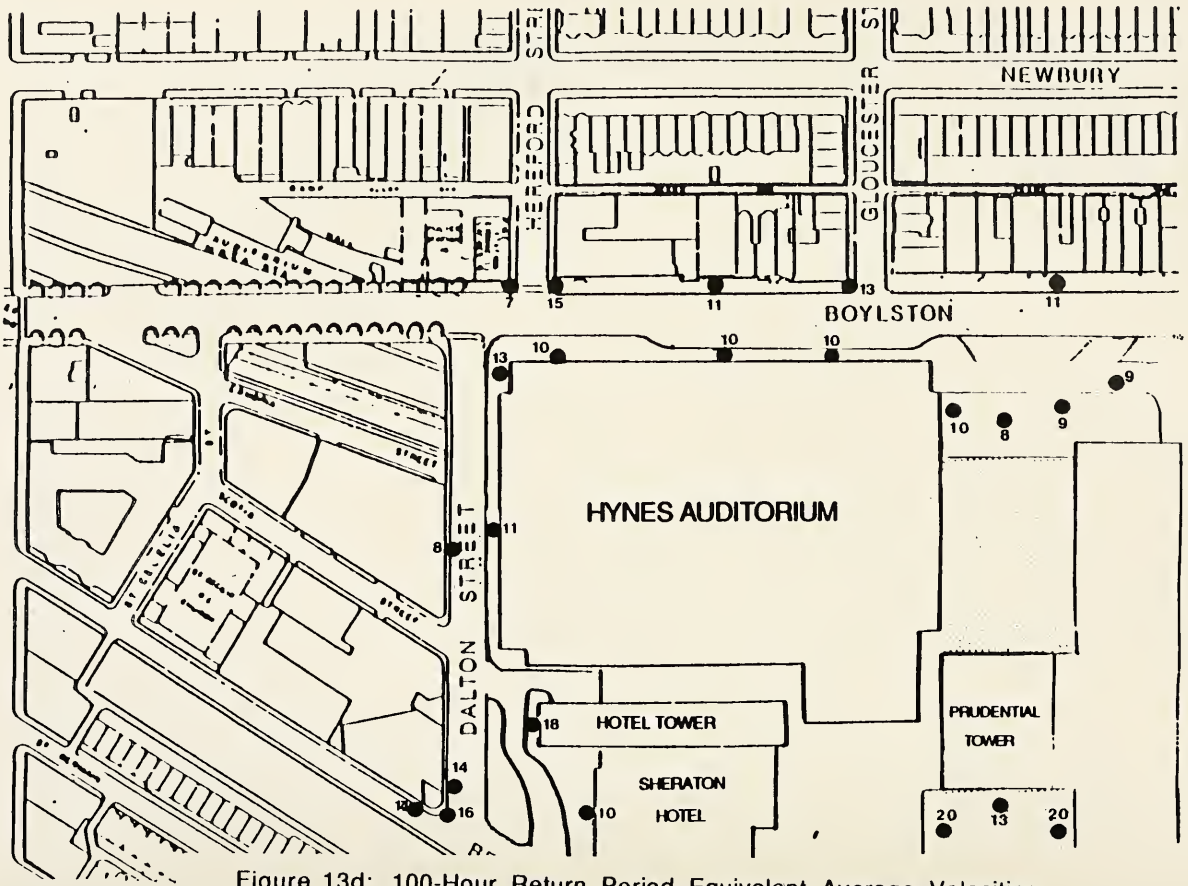


Figure 13d: 100-Hour Return Period Equivalent Average Velocities : Existing Configuration - NW quadrant

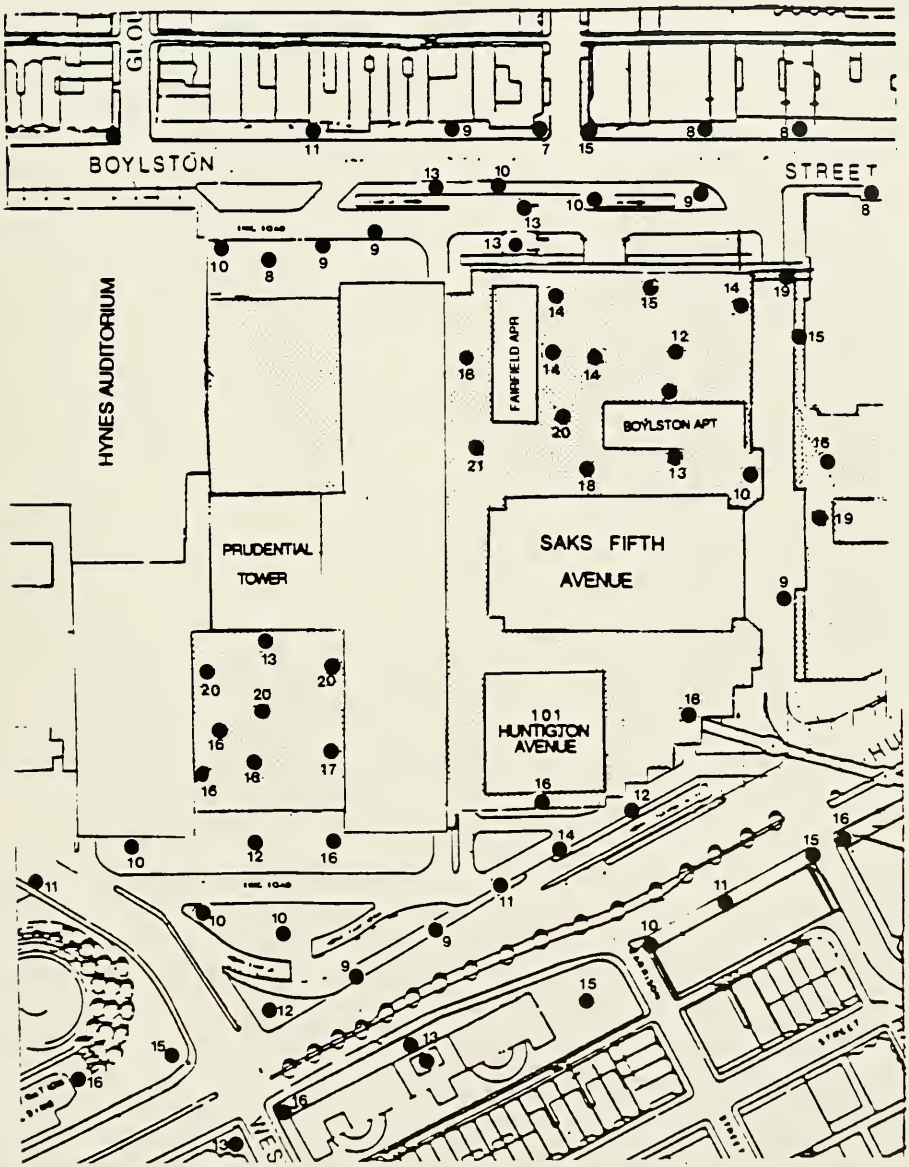


Figure 13e: 100-Hour Return Period Equivalent Average Velocities : Existing Configuration - Central

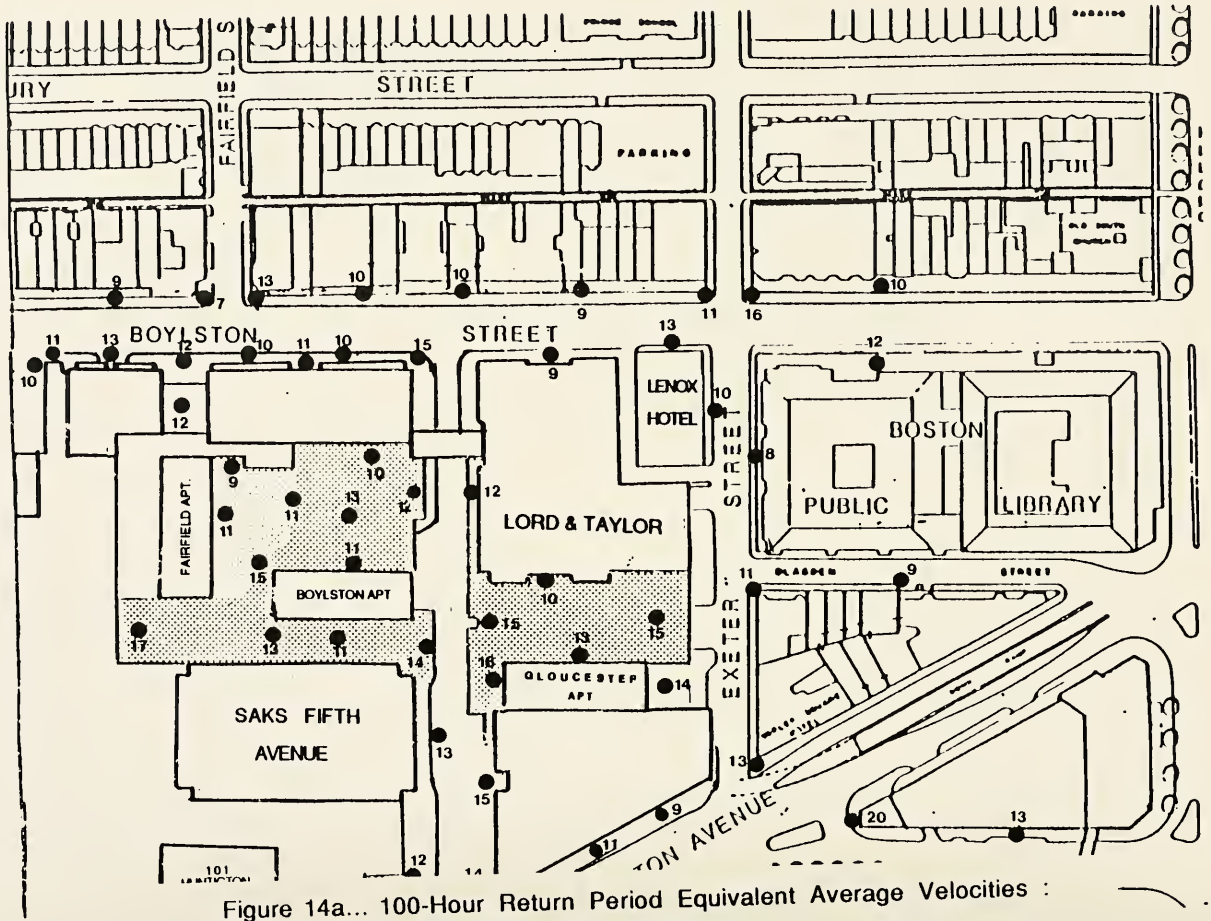


Figure 14a... 100-Hour Return Period Equivalent Average Velocities :
Configuration A - NE quadrant

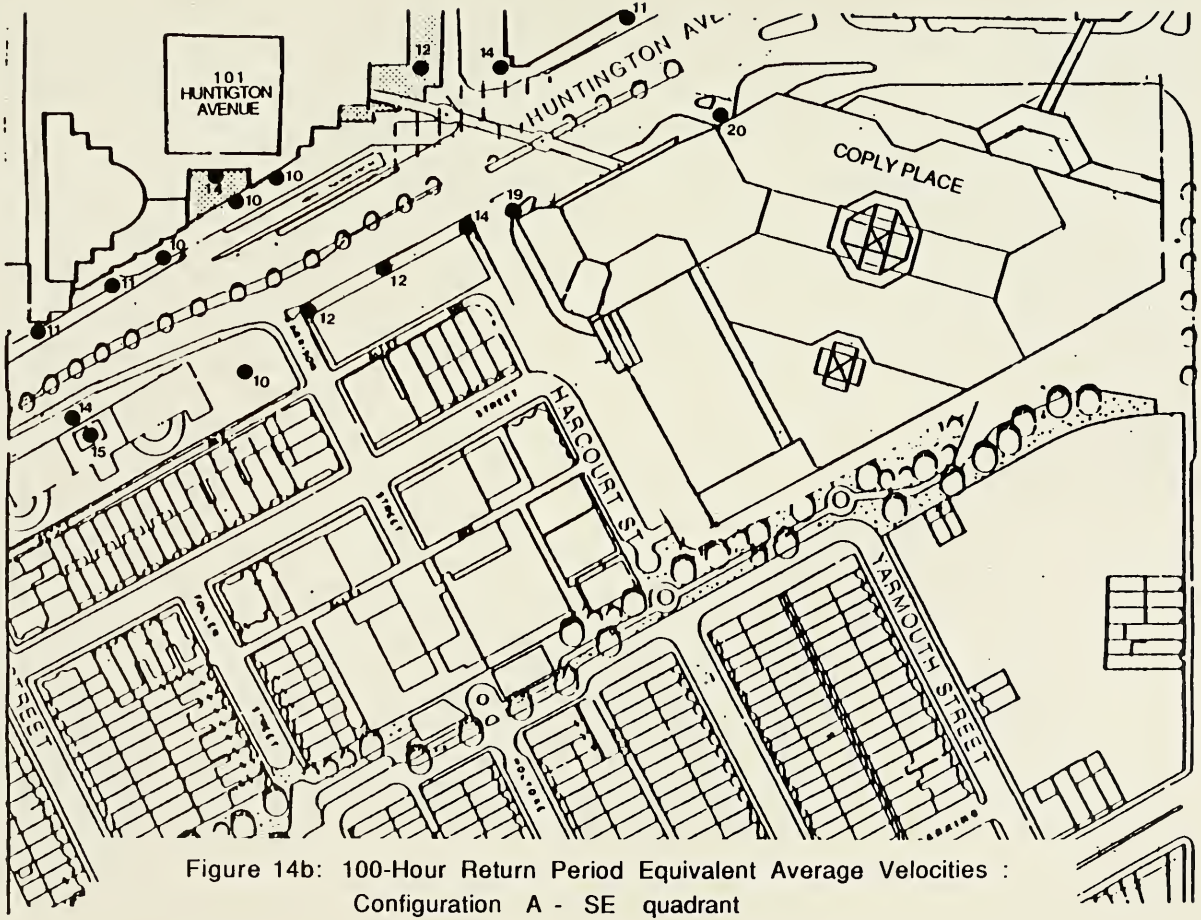


Figure 14b: 100-Hour Return Period Equivalent Average Velocities : Configuration A - SE quadrant

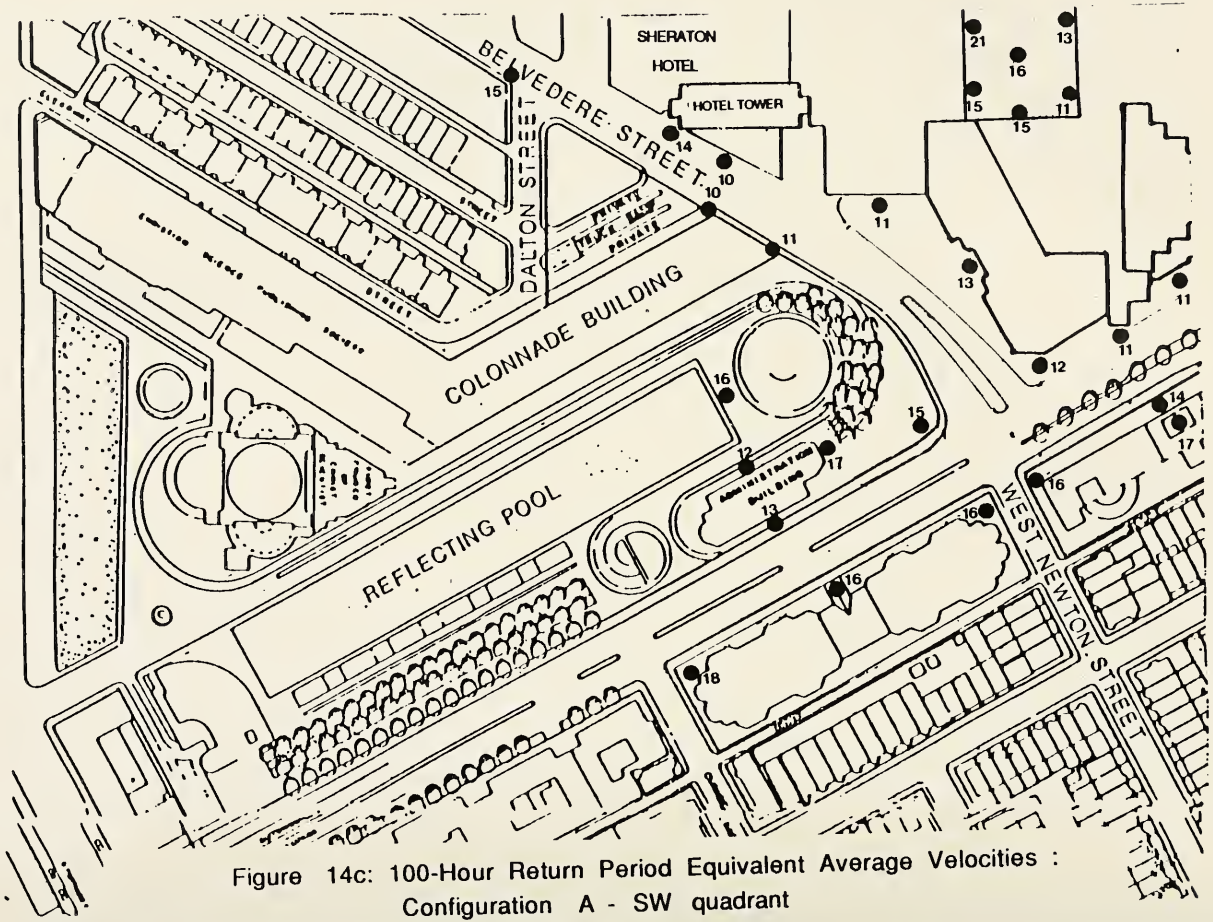


Figure 14c: 100-Hour Return Period Equivalent Average Velocities : Configuration A - SW quadrant

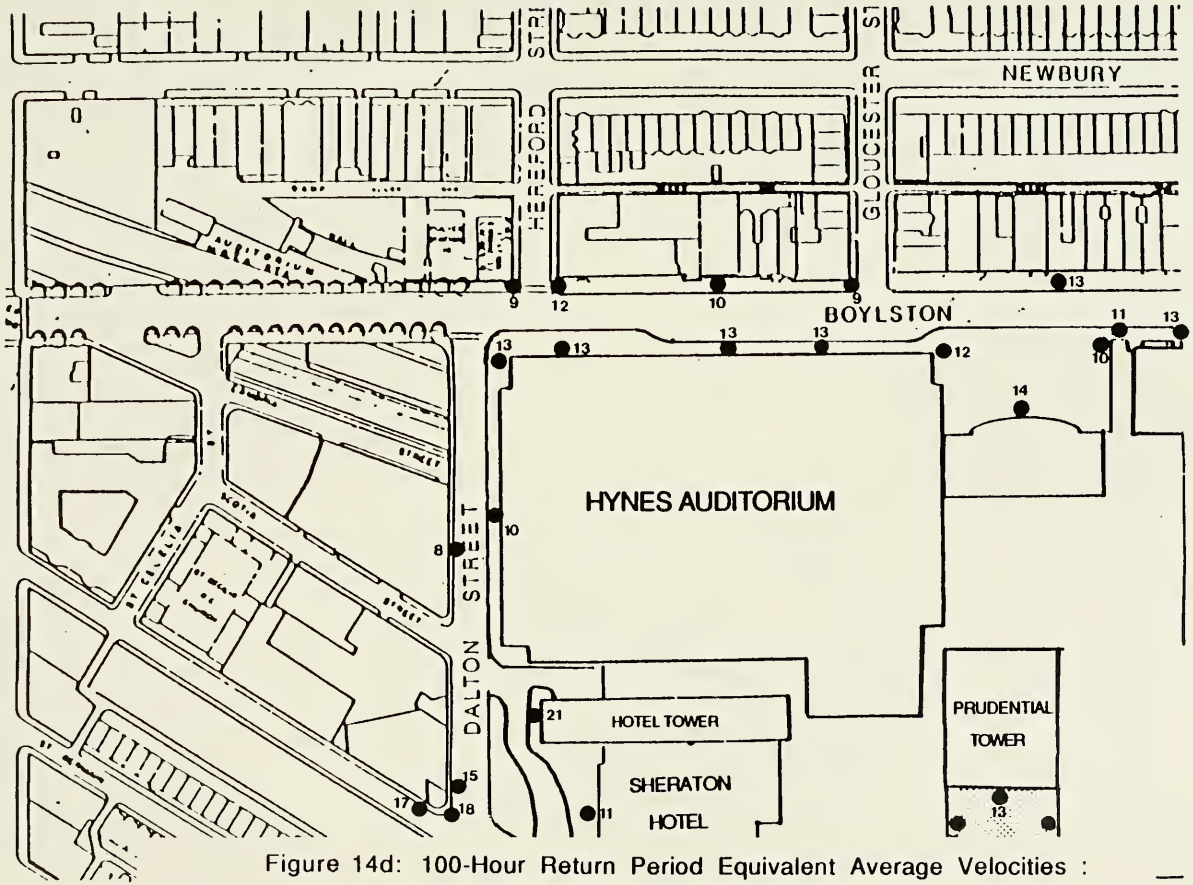


Figure 14d: 100-Hour Return Period Equivalent Average Velocities : Configuration A - NW quadrant

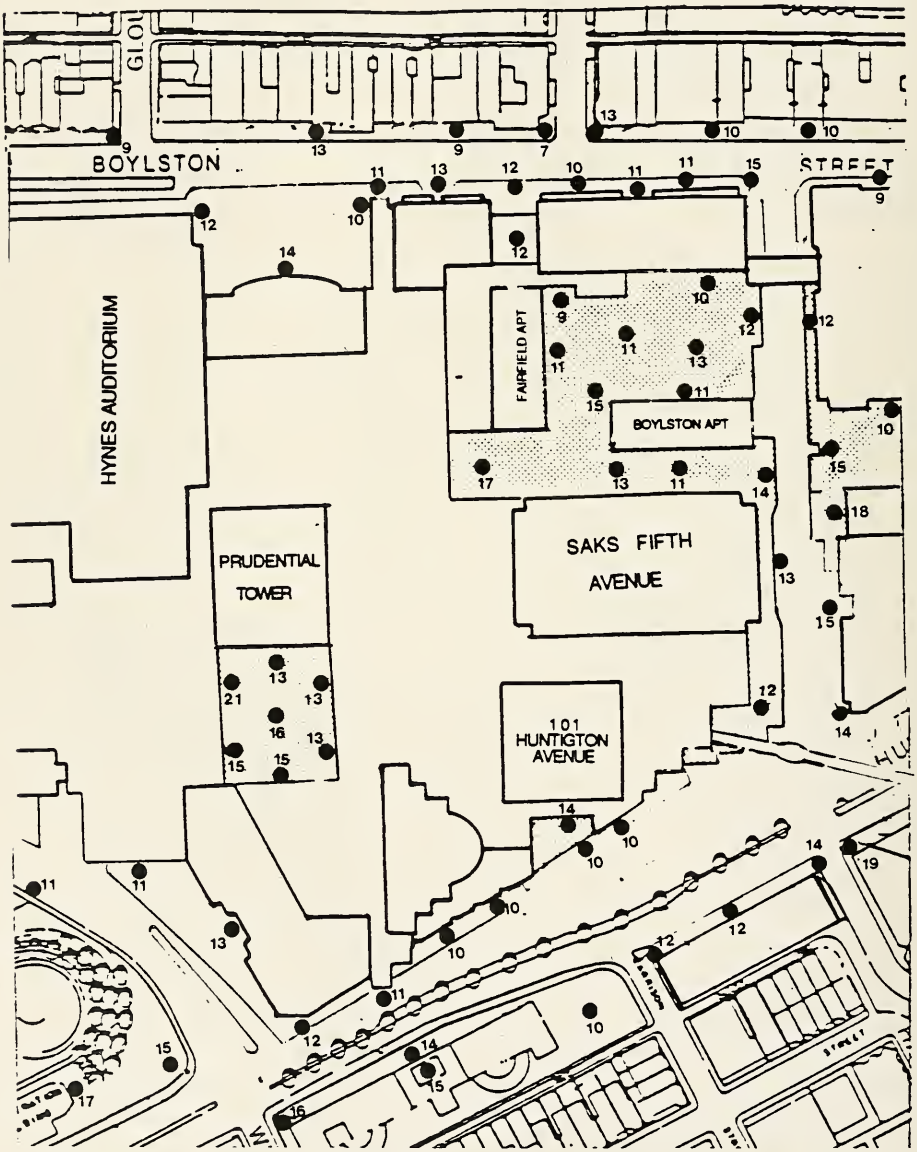


Figure 14e: 100-Hour Return Period Equivalent Average Velocities : Configuration A - Central

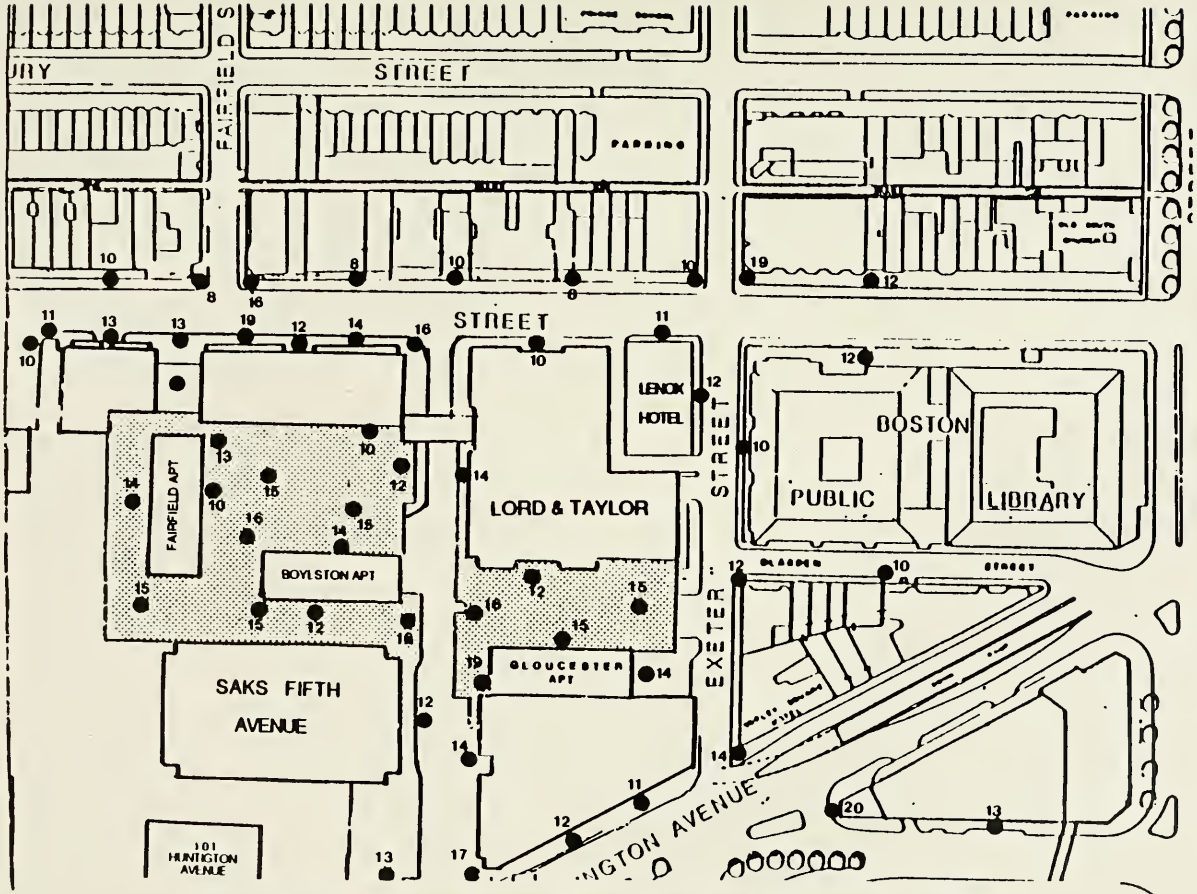


Figure 15a: 100-Hour Return Period Equivalent Average Velocities : Configuration C - NE quadrant

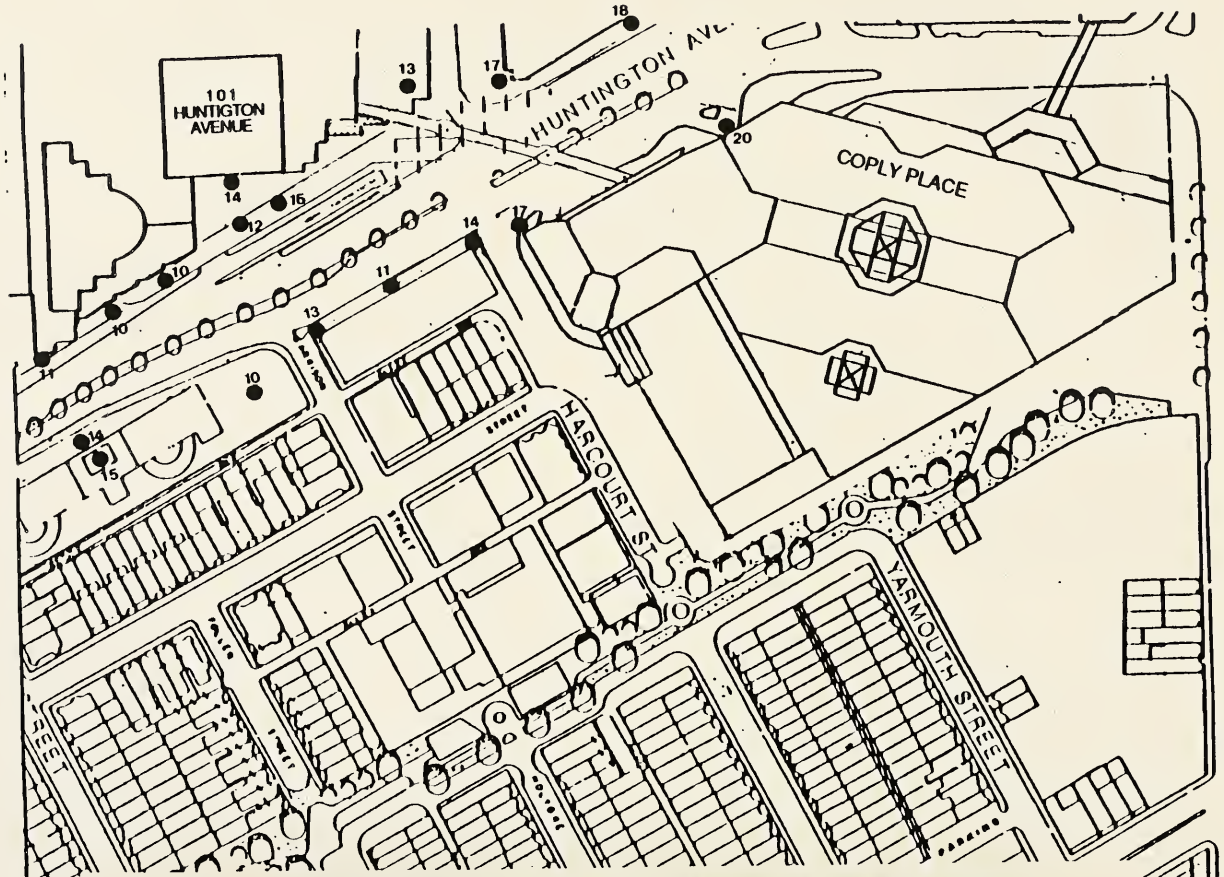


Figure 15b... 100-Hour Return Period Equivalent Average Velocities :
Configuration C - SE quadrant

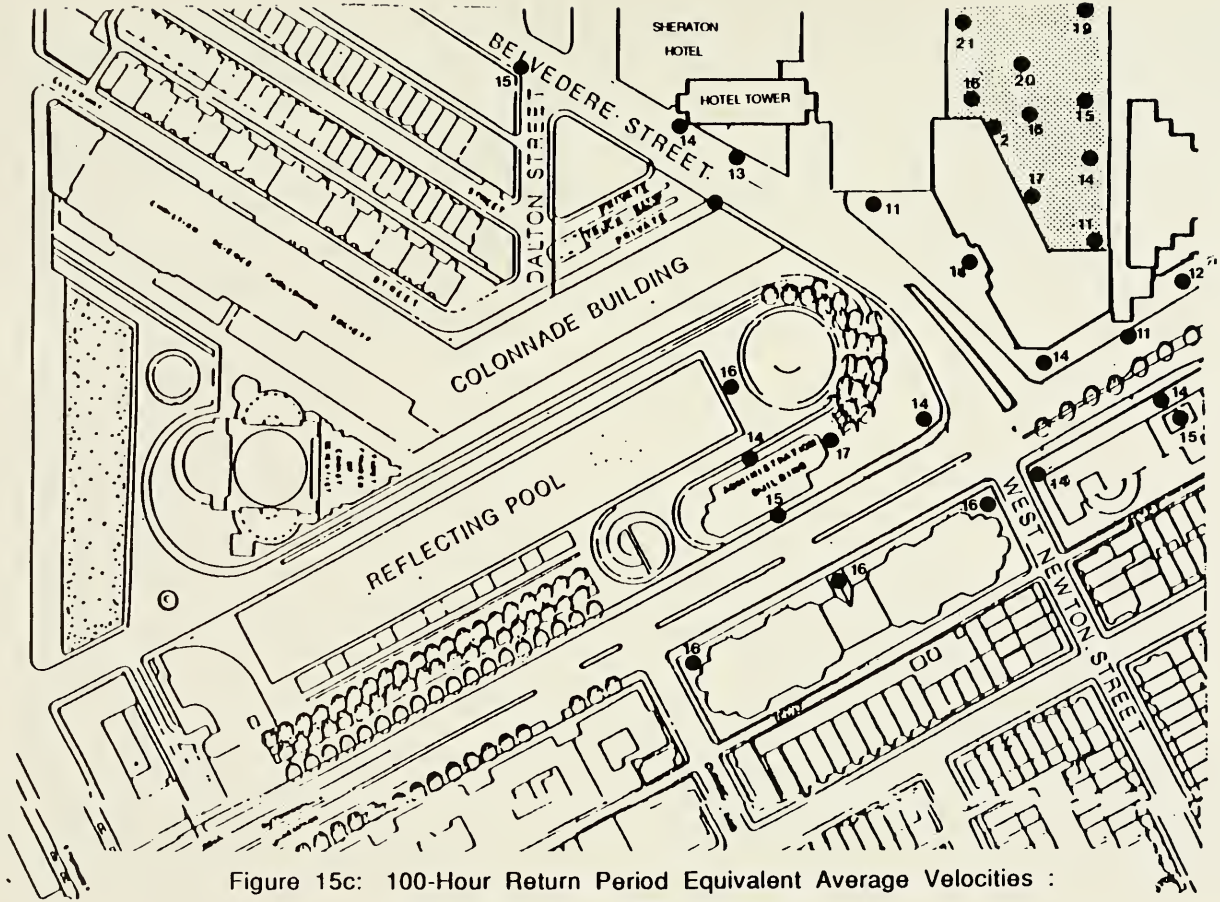


Figure 15c: 100-Hour Return Period Equivalent Average Velocities : Configuration C - SW quadrant

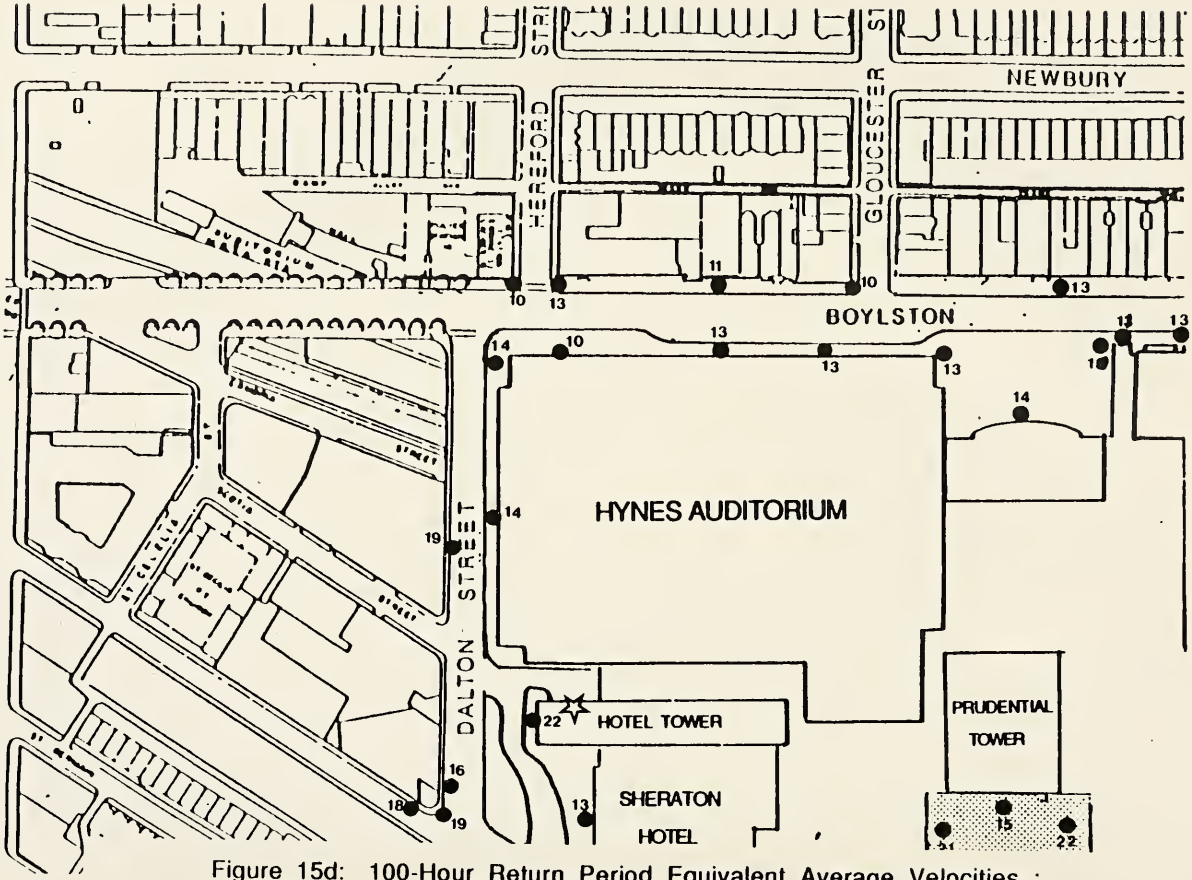


Figure 15d: 100-Hour Return Period Equivalent Average Velocities : Configuration C - NW quadrant

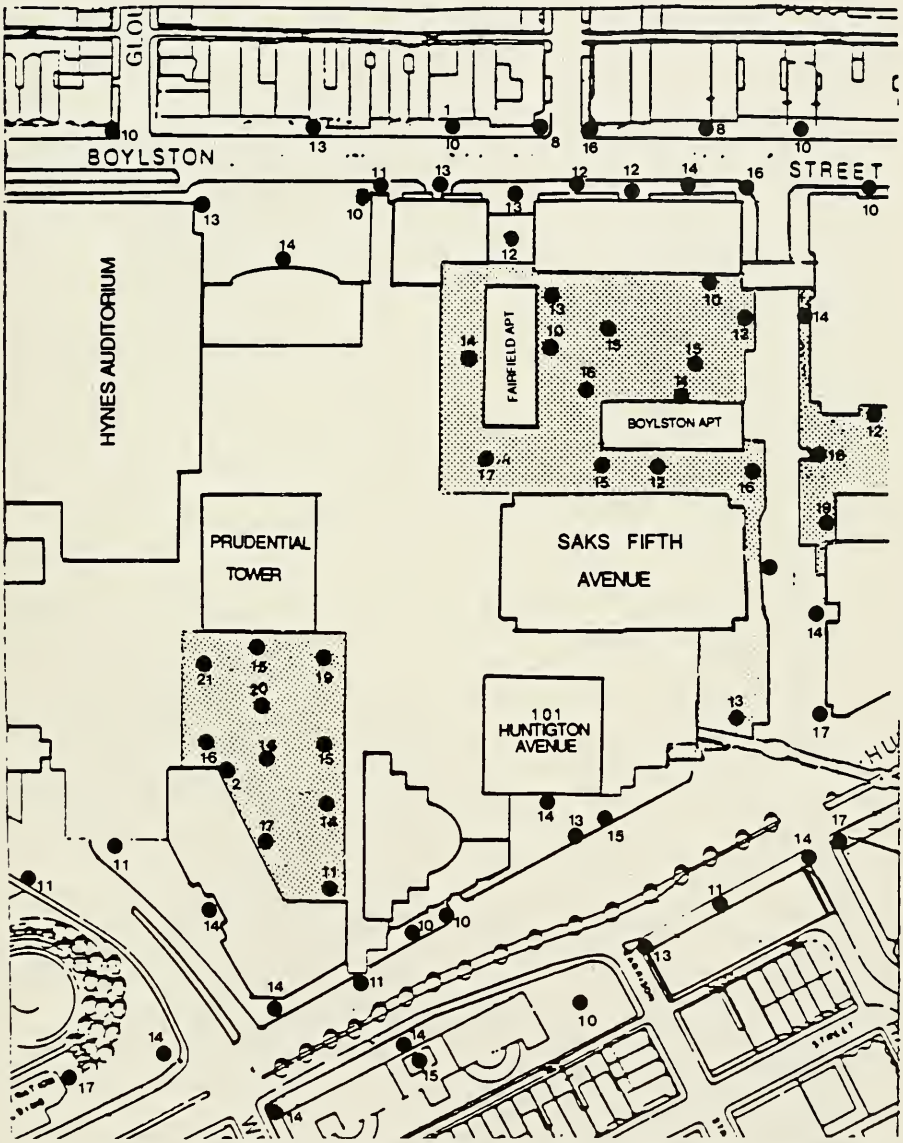


Figure 15e: 100-Hour Return Period Equivalent Average Velocities : Configuration C - Central

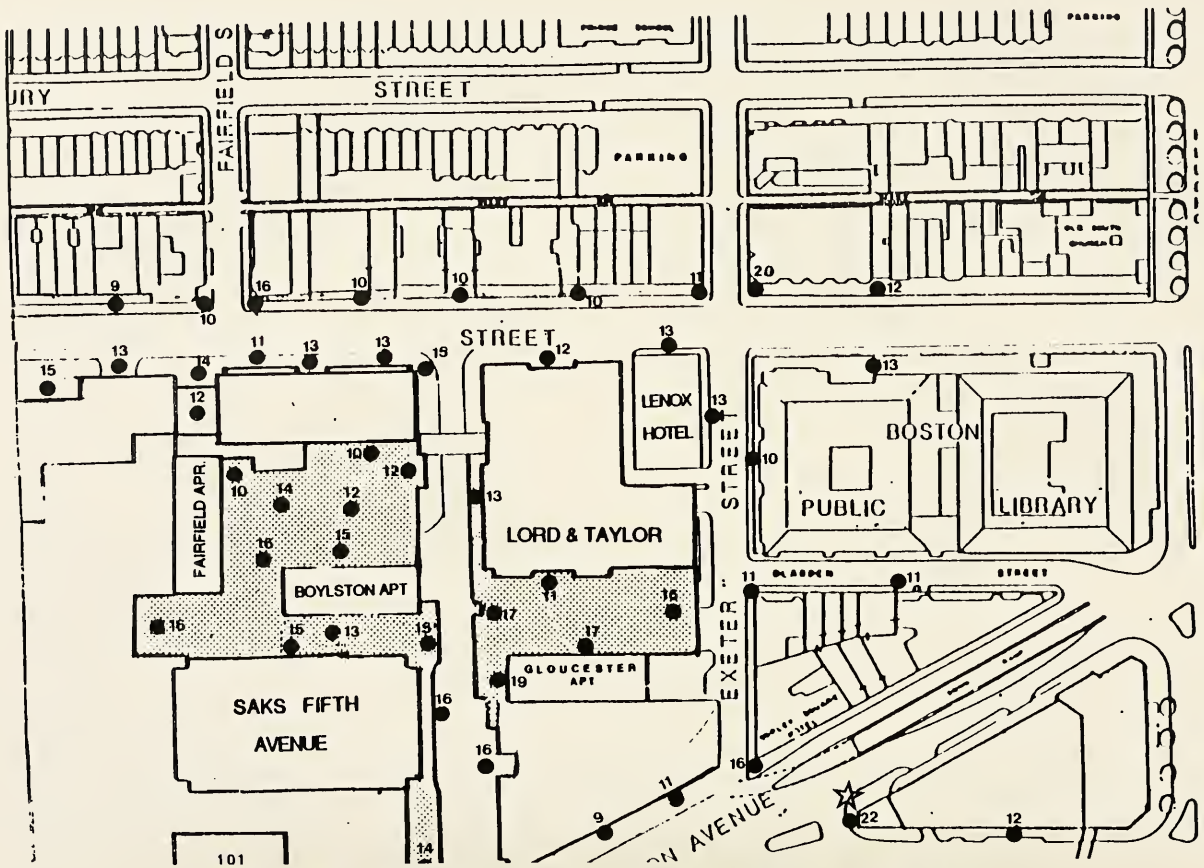


Figure 16a: 100-Hour Return Period Equivalent Average Velocities : Configuration A2 - NE quadrant

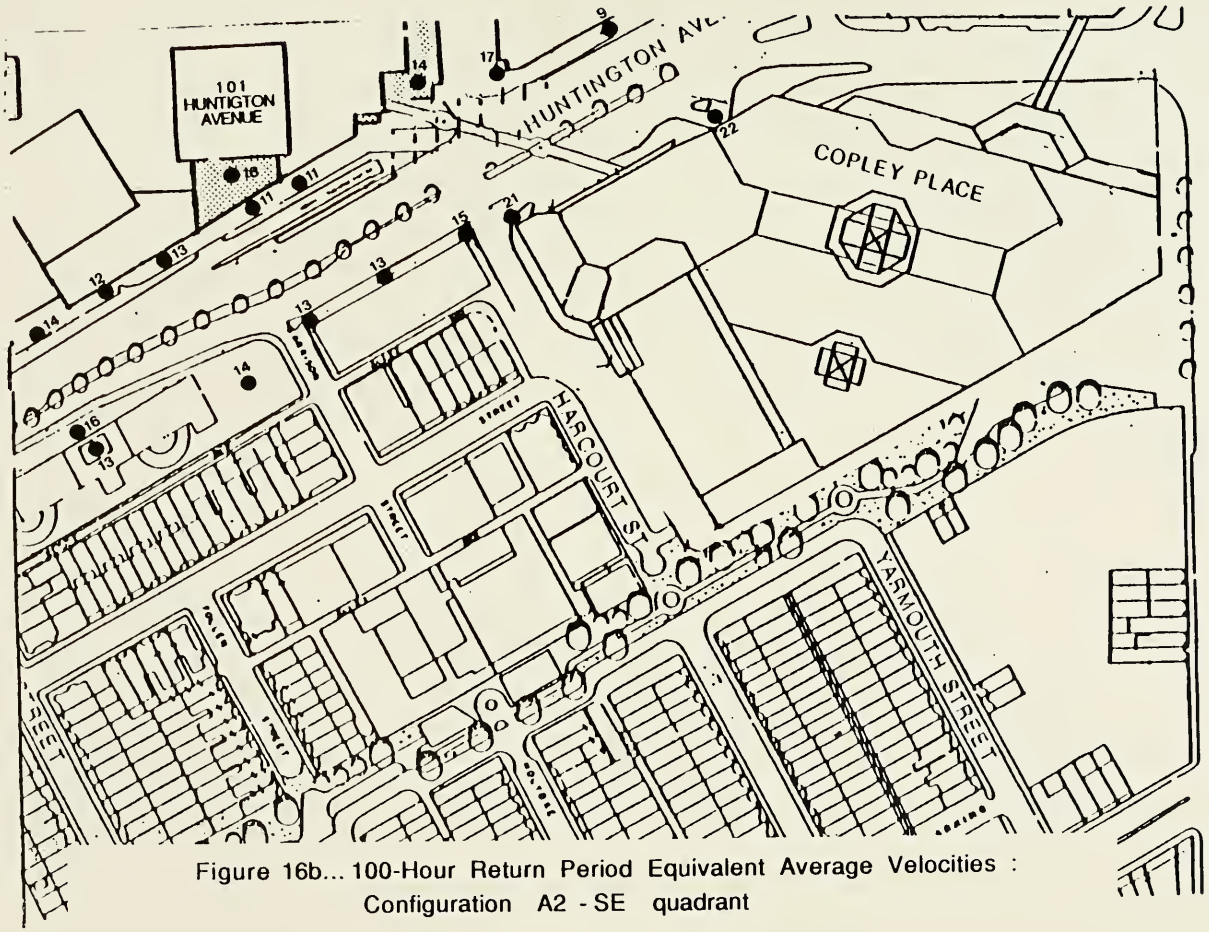


Figure 16b... 100-Hour Return Period Equivalent Average Velocities : Configuration A2 - SE quadrant

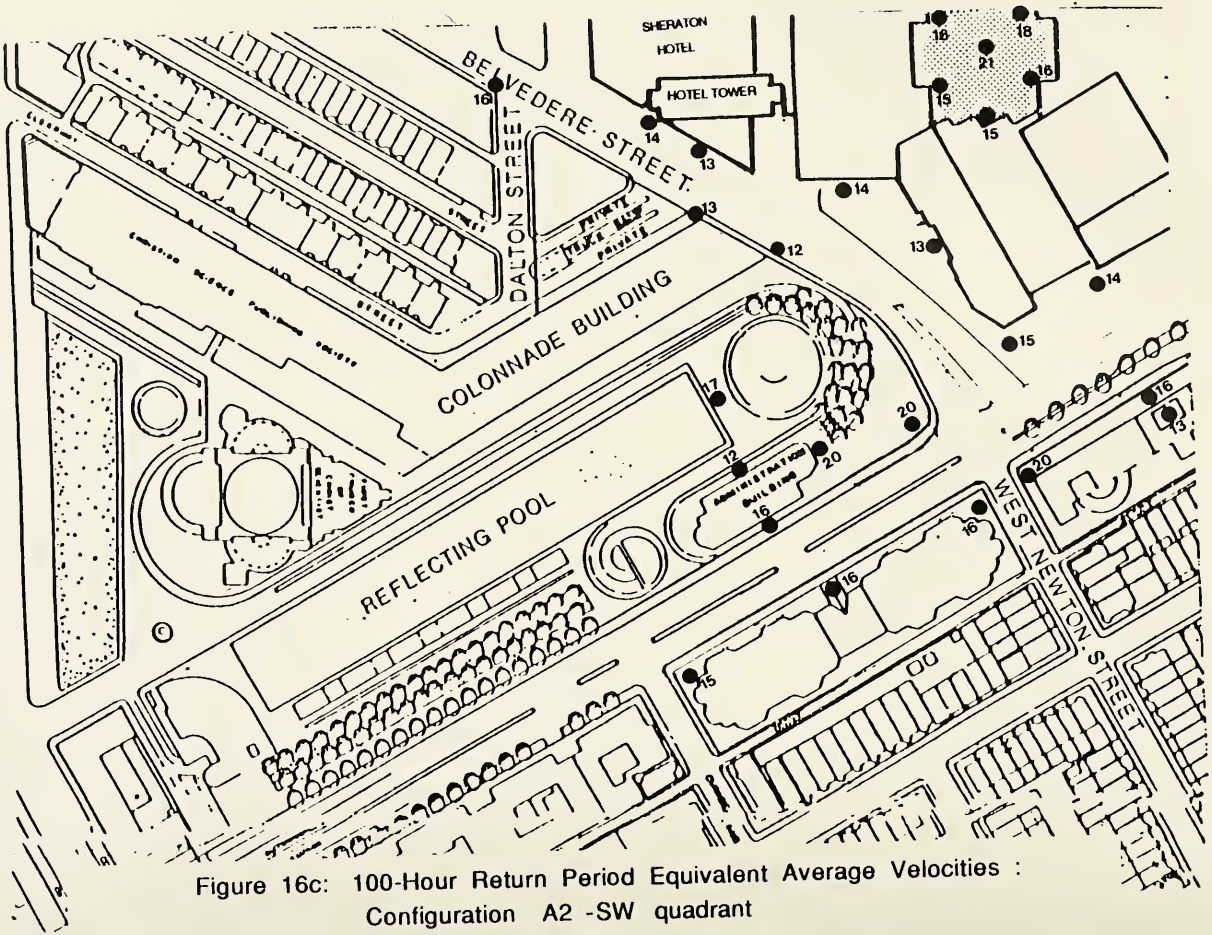


Figure 16c: 100-Hour Return Period Equivalent Average Velocities : Configuration A2 -SW quadrant

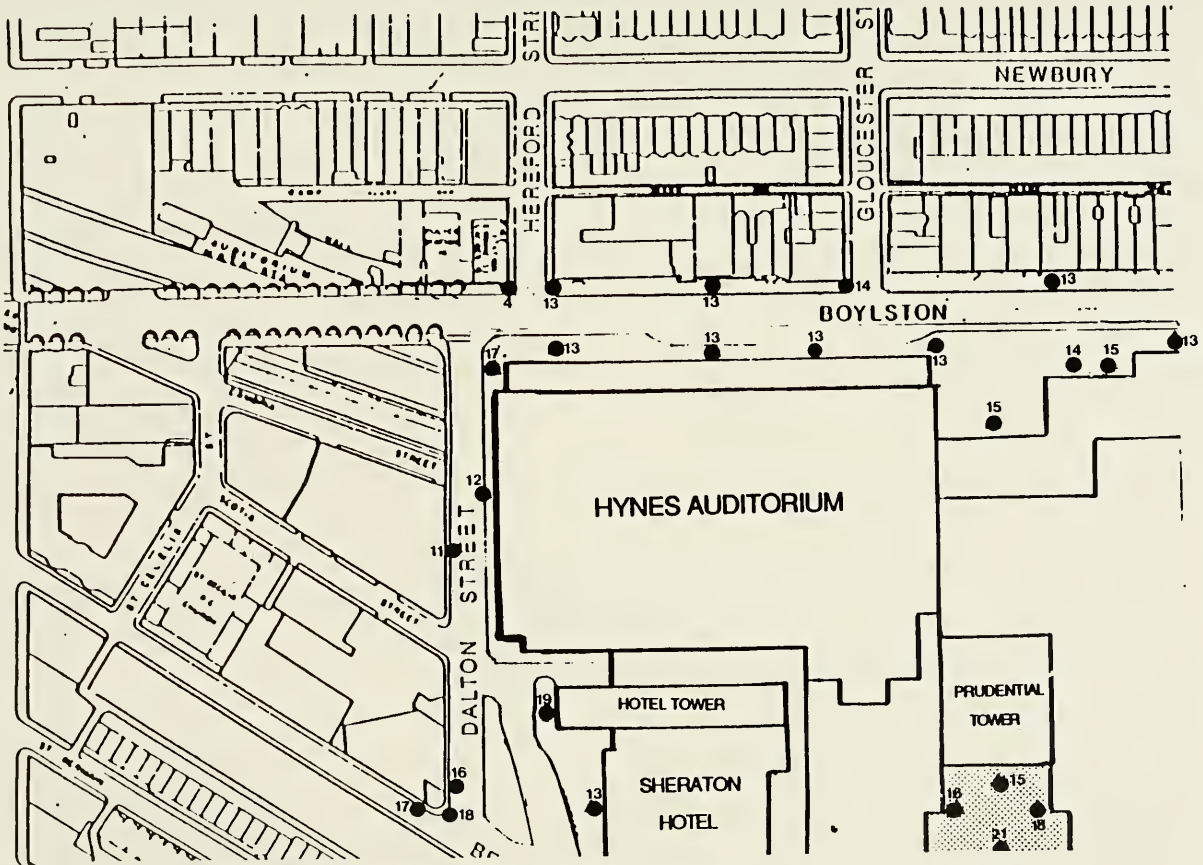


Figure 16d: 100-Hour Return Period Equivalent Average Velocities : Configuration A2 -NW quadrant

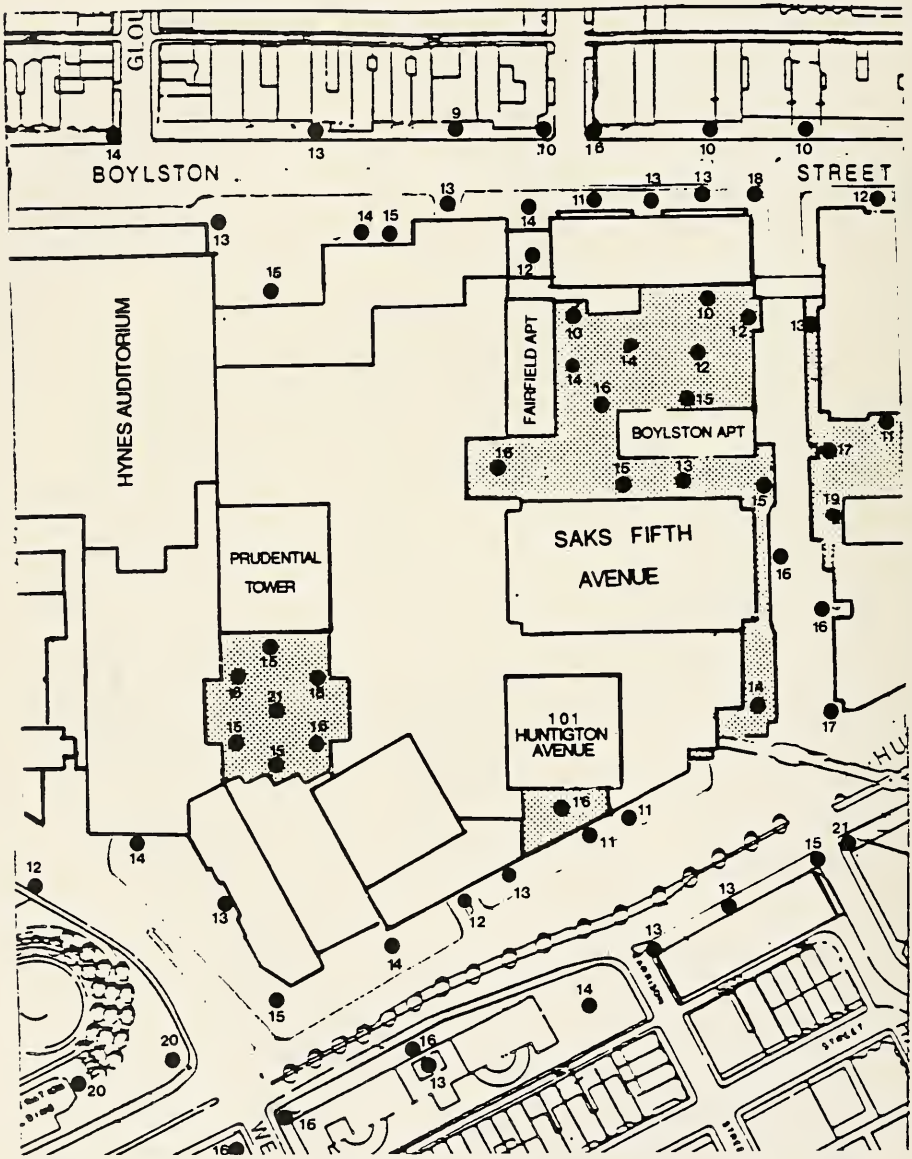


Figure 16e: 100-Hour Return Period Equivalent Average Velocities : Configuration A2 - Central

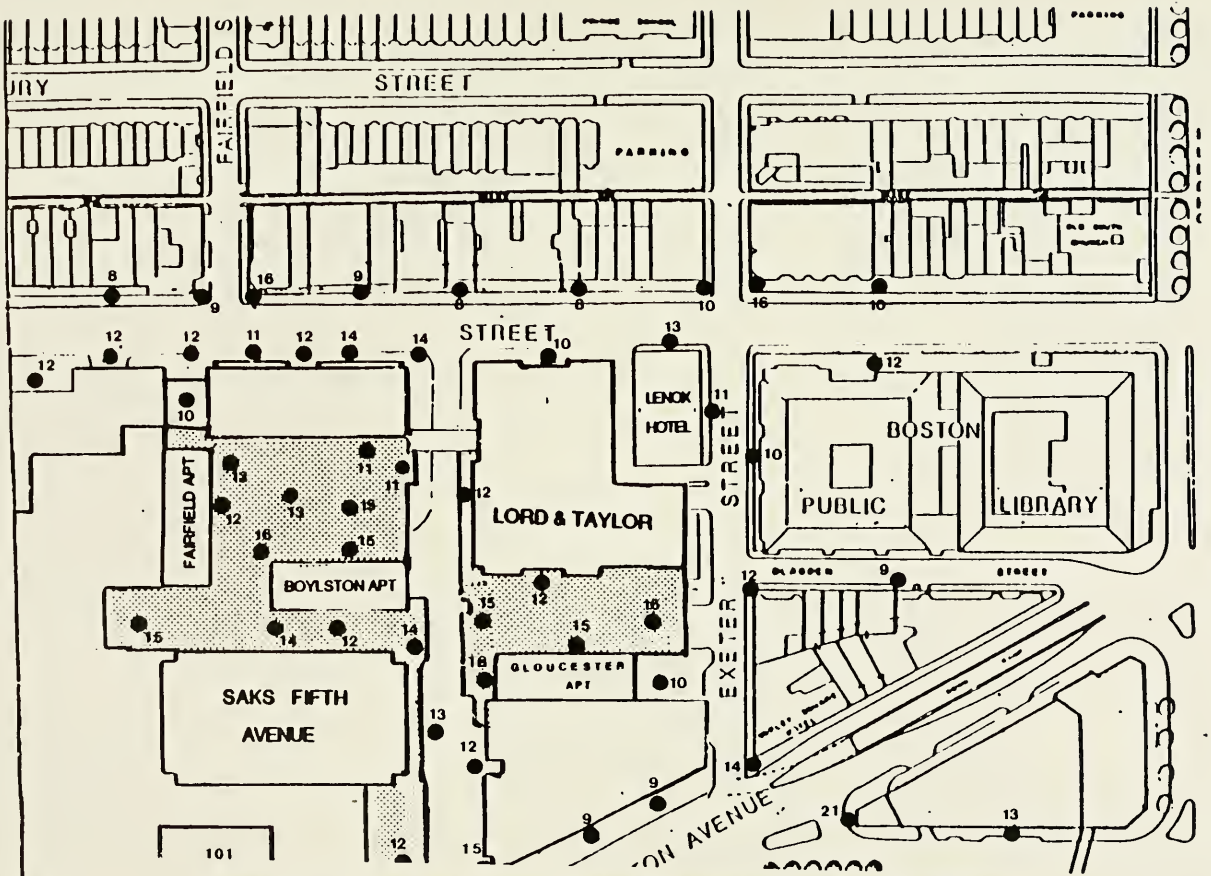


Figure 17a: 100-Hour Return Period Equivalent Average Velocities : Configuration C2 - NE quadrant

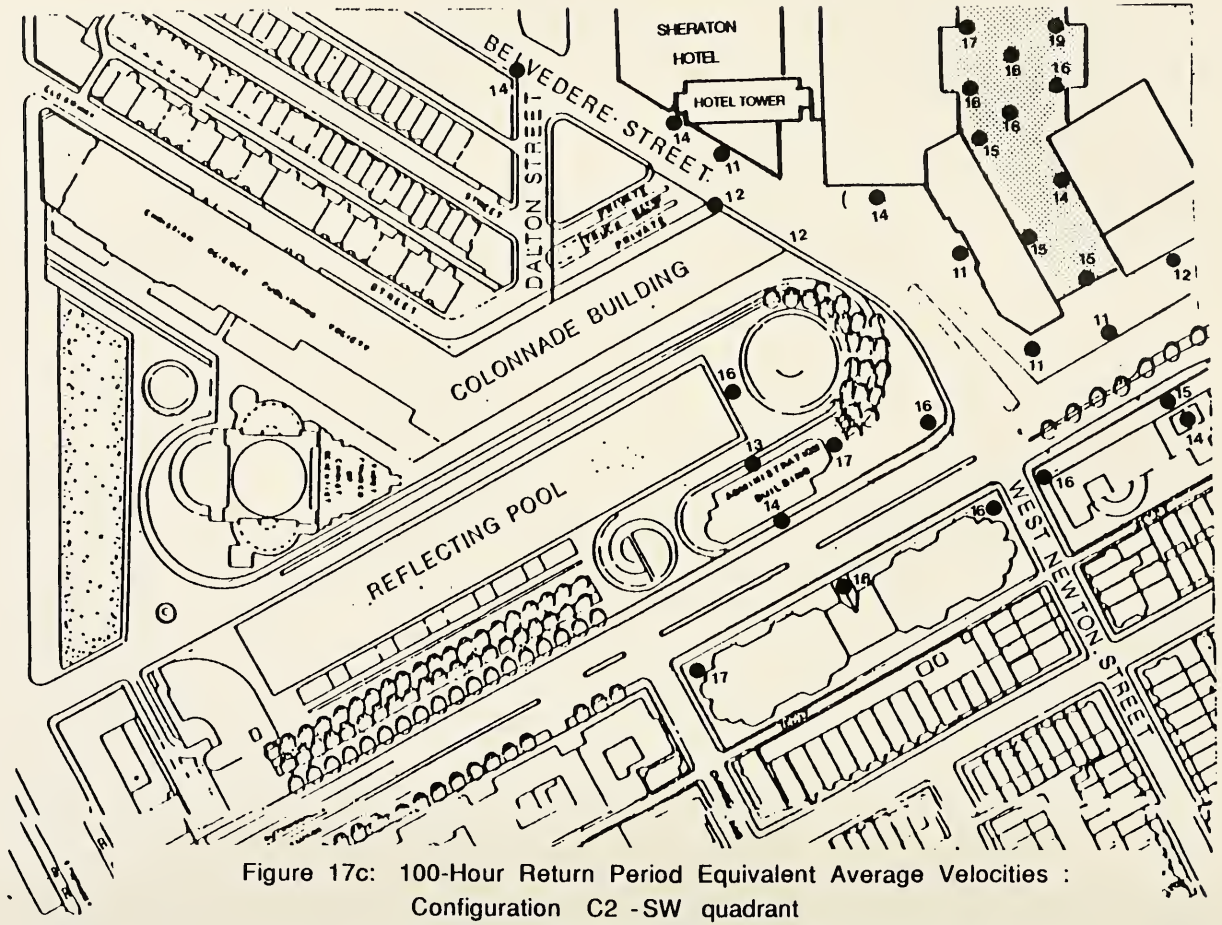


Figure 17c: 100-Hour Return Period Equivalent Average Velocities : Configuration C2 - SW quadrant

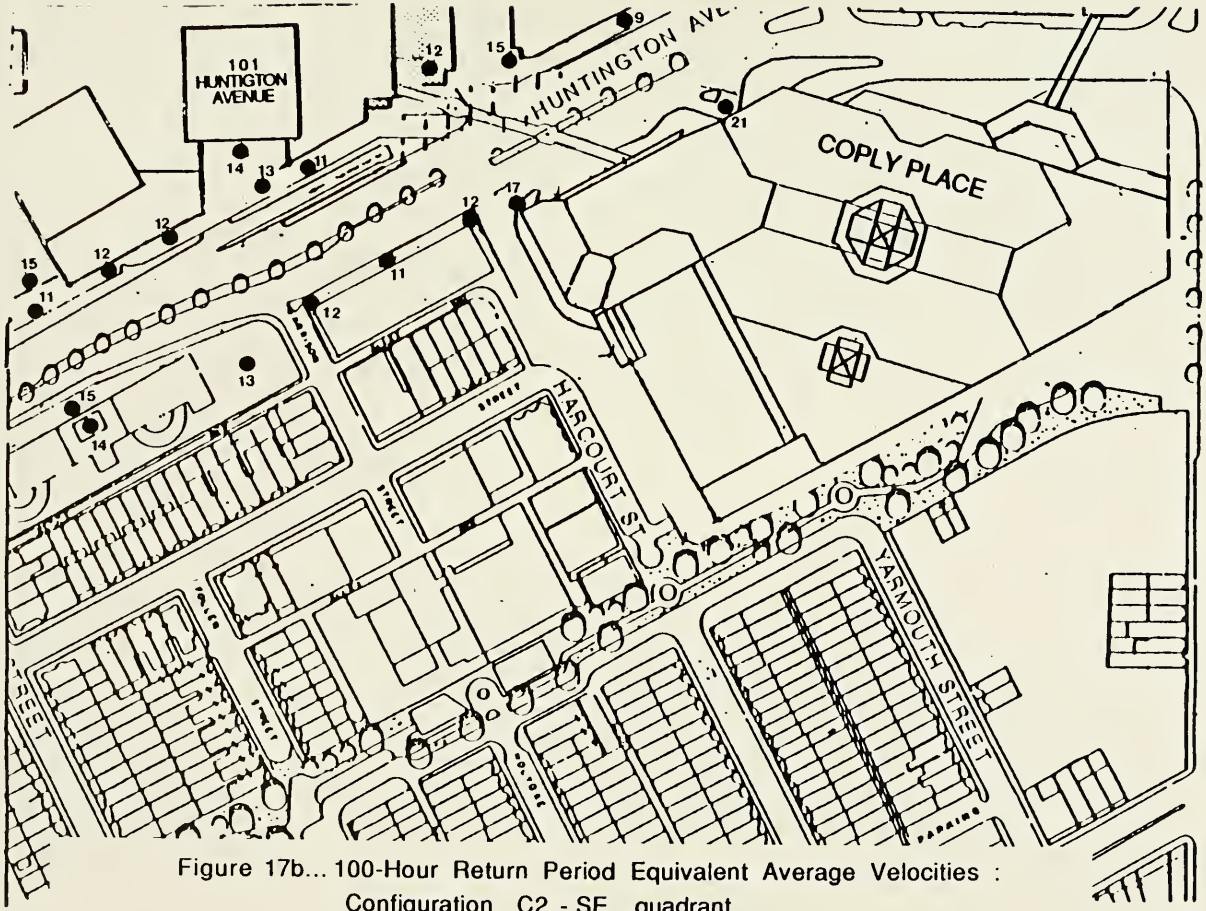


Figure 17b... 100-Hour Return Period Equivalent Average Velocities :
Configuration C2 - SE quadrant

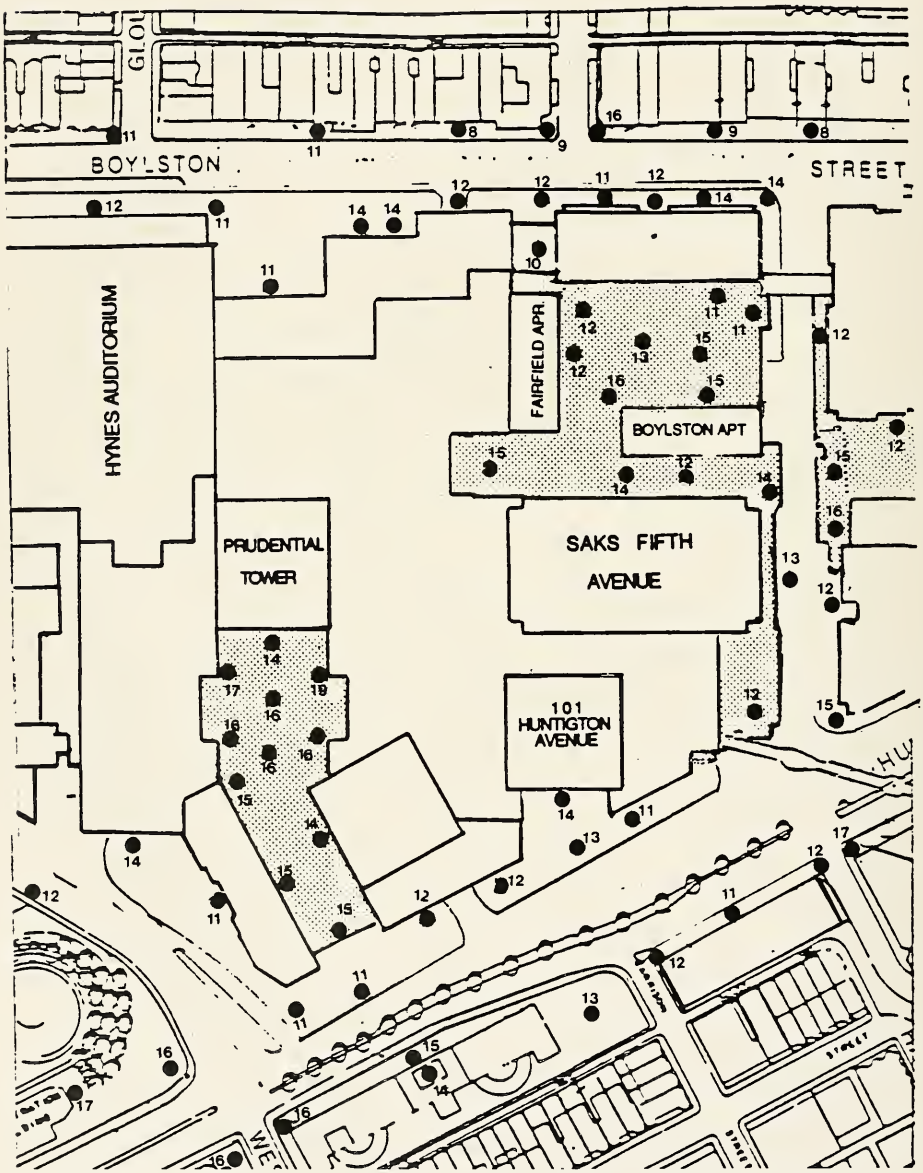


Figure 17e: 100-Hour Return Period Equivalent Average Velocities : Configuration C2 - Central

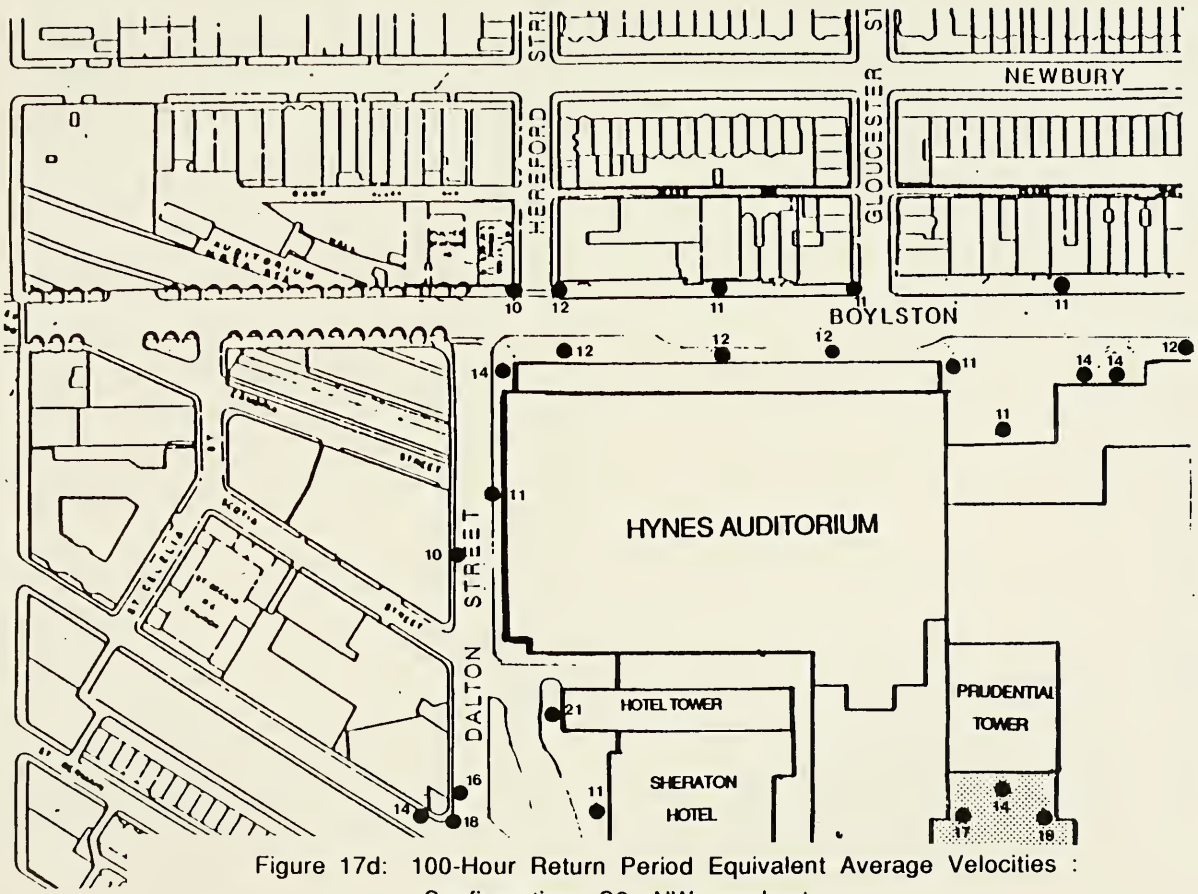


Figure 17d: 100-Hour Return Period Equivalent Average Velocities : Configuration C2 - NW quadrant

TABLE 3

TOTAL LOCATIONS THAT EXCEED THE BRA GUIDELINE
WIND SPEED AND IN EACH MELBOURNE CATEGORY - ANNUAL

CONFIGURATION	EXISTING	BUILD	BUILD2	A	C	A2	C2
BRA GUIDELINE	0	0	0	0	1	1	0
MELBOURNE 1	0	0	0	0	0	0	0
MELBOURNE 2	8	4	0	4	9	8	3
MELBOURNE 3	31	27	16	23	28	36	30
MELBOURNE 4	27	30	32	39	49	46	45
MELBOURNE 5	49	40	50	43	28	19	35
TOTAL LOCATIONS	115	101	98	109	114	109	113

TABLE 4

NUMBER OF LOCATIONS THAT EXCEED THE BRA GUIDELINE
WIND SPEED AND IN EACH MELBOURNE CATEGORY - WINTER

CONFIGURATION	EXISTING	BUILD	BUILD2	A	C	A2	C2
BRA GUIDELINE	3	3	0	3	5	6	2
MELBOURNE 1	0	0	0	0	0	0	0
MELBOURNE 2	10	9	2	8	12	9	4
MELBOURNE 3	36	29	23	26	41	42	37
MELBOURNE 4	27	31	31	43	38	43	37
MELBOURNE 5	42	32	42	32	23	16	21
TOTAL LOCATIONS	115	101	98	109	114	109	113

TABLE 5

NUMBER OF LOCATIONS THAT EXCEED THE BRA GUIDELINE WIND SPEED AND IN EACH MELBOURNE CATEGORY - SPRING

CONFIGURATION	EXISTING	BUILD	BUILD2	A	C	A2	C2
BRA GUIDELINE	3	0	0	1	2	2	1
MELBOURNE 1	0	0	0	0	0	0	0
MELBOURNE 2	9	7	2	7	10	10	4
MELBOURNE 3	40	27	21	25	41	44	31
MELBOURNE 4	24	35	35	45	41	41	43
MELBOURNE 5	42	32	40	32	22	15	21
TOTAL LOCATIONS	115	101	98	109	114	109	113

TABLE 6

NUMBER OF LOCATIONS THAT EXCEED THE BRA GUIDELINE WIND SPEED AND IN EACH MELBOURNE CATEGORY - SUMMER

CONFIGURATION	EXISTING	BUILD	BUILD2	A	C	A2	C2
BRA GUIDELINE	0	0	0	0	0	0	0
MELBOURNE 1	0	0	0	0	0	0	0
MELBOURNE 2	0	0	0	0	0	0	0
MELBOURNE 3	10	8	2	8	10	13	4
MELBOURNE 4	35	26	21	21	42	41	34
MELBOURNE 5	70	67	75	80	62	56	75
TOTAL LOCATIONS	115	101	98	109	114	109	113

TABLE 7

NUMBER OF LOCATIONS THAT EXCEED THE BRA GUIDELINE WIND SPEED AND IN EACH MELBOURNE CATEGORY - FALL

CONFIGURATION	EXISTING	BUILD	BUILD2	A	C	A2	C2
BRA GUIDELINE	0	0	0	0	0	0	0
MELBOURNE 1	0	0	0	0	0	0	0
MELBOURNE 2	4	4	0	3	4	7	3
MELBOURNE 3	22	20	11	10	23	30	16
MELBOURNE 4	37	30	29	47	54	49	46
MELBOURNE 5	52	47	58	49	33	24	48
TOTAL LOCATIONS	115	101	98	109	114	109	113

TABLE 8

ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
1	16	16	16	18	16	16	17	3	3	3	3	3	3	3
2	15	16	13	16	16	16	16	3	3	3	3	3	3	3
3	13	14	15	16	16	16	16	4	4	3	3	3	3	3
4	16	16	14	16	14	14	16	3	3	4	3	4	4	3
5	14	14	12	13	14	16	14	4	4	4	4	4	3	4
6	16	17	15	17	17	20	17	3	3	3	3	3	2	3
7	15	16	14	15	14	20	16	3	3	4	3	4	2	3
8	10	12	10	13	14	13	11	5	4	5	4	4	4	5
9	11	12	13	12	14	12	13	5	4	4	4	4	4	4
10	15	15	15	16	16	17	16	3	3	3	3	3	3	3
11	11	11	10	11	11	12	12	5	5	5	5	5	4	4
12	10	10	10	10	11	13	12	5	5	5	5	5	4	4
13	10	12	12	10	13	13	11	5	4	4	5	4	4	5
14	11	13	13	14	14	14	14	5	4	4	4	4	4	4
15	16	16	15	15	16	16	14	3	3	3	3	3	3	4
16	10	11	10	11	13	13	11	5	5	5	5	4	4	5
17	14	18	14	17	17	17	14	4	3	4	3	3	3	4
18	16	18	14	18	19	18	18	3	3	4	3	2	3	3
19	14	15	14	15	15	16	16	4	3	4	3	3	3	3
20	18	20	18	21	22*	19	21	3	2	3	2	2*	3	3
21	8	9	9	8	9	11	10	5	5	5	5	5	5	5
22	11	10	10	10	14	12	11	5	5	5	5	4	4	5
23	13	12	12	13	14	17	14	4	4	4	4	4	3	4
24	7	7	7	9	10	11	10	5	5	5	5	5	5	5
25	10	11	10	13	13	13	13	5	5	5	4	4	4	4
26	15	13	12	12	13	13	12	3	4	4	4	4	4	4
27	10	15	9	13	13	13	12	5	3	5	4	4	4	4
28	11	8	8	10	11	13	11	5	5	5	5	5	4	5
29	10	12	9	13	13	13	12	5	4	5	4	4	4	4
30	13	12	11	9	10	14	11	4	4	5	5	5	4	5
31	10	12	9	12	13	13	11	5	4	5	4	4	4	5
32	11	10	11	13	13	13	11	5	5	5	4	4	4	5
33	8	14	12	14	14	15	13	5	4	4	4	4	3	4
34	9	11	12	10	13	14	14	5	5	4	5	4	4	4
35	9	15	12	11	13	15	14	5	3	4	5	4	3	4

TABLE 8 (cont.)

ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
36	9	8	9	9	10	9	8	5	5	5	5	5	5	5
37	10	10	9	13	13	13	12	5	5	5	4	4	4	4
38	7	9	7	7	8	10	9	5	5	5	5	5	5	5
39	10	10	8	10	9	11	11	5	5	5	5	5	5	5
40	15	13	13	13	16	16	16	3	4	4	4	3	3	3
41	10	10	10	11	12	13	12	5	5	5	5	4	4	4
42	8	7	7	10	8	10	9	5	5	5	5	5	5	5
43	9	13	10	15	16	15	14	5	4	5	3	3	3	4
44	8	8	8	10	10	10	8	5	5	5	5	5	5	5
45	8	8	8	9	10	12	10	5	5	5	5	5	4	5
46	7	8	7	9	8	10	8	5	5	5	5	5	5	5
47	12	13	13	13	11	13	13	4	4	4	4	5	4	4
48	9	9	9	11	10	11	10	5	5	5	5	5	5	5
49	16	15	12	16	19	20	16	3	3	4	3	2	2	3
50	11	11	9	10	12	12	10	5	5	5	5	4	4	5
51	12	11	11	12	12	13	12	4	5	5	4	4	4	4
52	10	10	11	10	12	13	11	5	5	5	5	4	4	5
53	9	8	8	8	10	10	10	5	5	5	5	5	5	5
54	9	10	8	9	9	11	9	5	5	5	5	5	5	5
55	10	10	8	11	12	11	12	5	5	5	5	4	5	4
56	14	14	13	13	14	16	14	4	4	4	4	4	3	4
57	17	20	14	20	20	22+	21	3	2	4	2	2	2+	2
58	14	12	11	13	12	12	13	4	4	5	4	4	4	4
59	11	10	9	11	10	12	11	5	5	5	5	5	4	5
60	8	8	8	9	11	11	9	5	5	5	5	5	5	5
61	7	10	8	11	12	9	9	5	5	5	5	4	5	5
62	9	8	8	14	17	17	15	5	5	5	4	3	3	3
63	16	18	14	19	17	21	17	3	3	4	2	3	2	3
64	11	11	8	13	12	16	13	5	5	5	4	4	3	5
65	15	14	14	14	14	15	12	3	4	4	4	4	3	4
66	11	13	11	12	11	13	11	5	4	5	4	5	4	5
67	12	11	9	10	15	11	11	4	5	5	5	3	5	5
68	10	11	10	12	13	13	12	5	5	5	4	4	4	4
69	15	10	10	10	10	14	13	3	5	5	5	5	4	4
70	11	7	9	10	10	13	12	5	5	5	5	5	4	4

TABLE 8 (cont.)

ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATION OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
71	9	8	9	11	10	12	12	5	5	5	5	5	4	4
72	13	12	9	14	14	16	15	4	4	5	4	4	3	3
73	9	9	12	11	11	14	11	5	5	4	5	5	4	5
74	12	15	13	12	14	15	11	4	3	4	4	4	3	5
75	16	16	--	15	16	15	16	3	3	-	3	3	3	3
76	16	20	15	15	16	15	16	3	2	3	3	3	3	3
77	20	16	16	21	21	16	17	2	3	3	2	2	3	3
78	20	20	16	16	20	21	18	2	2	3	3	2	2	3
79	13	15	12	13	15	15	14	4	3	4	4	3	3	4
80	16	18	15	--	14	--	14	3	3	3	-	4	-	4
81	17	15	13	11	15	16	16	3	3	4	4	3	3	3
82	20	15	15	14	19	18	19	2	3	3	4	2	3	2
83	16	11	11	12	13	14	12	3	5	5	4	4	4	4
84	20	16	15	15	16	16	16	2	3	3	3	3	3	3
85	14	13	11	11	10	14	12	4	4	5	5	5	4	4
86	17	13	14	9	13	10	12	3	4	4	5	4	5	4
87	13	14	--	12	12	12	10	4	4	-	4	4	4	5
88	13	10	--	12	13	14	12	4	5	-	4	4	4	4
89	13	12	13	11	14	15	15	4	4	4	5	4	3	3
90	14	12	11	11	15	14	13	4	4	5	5	3	4	4
91	12	13	11	13	15	12	15	4	4	5	4	3	4	3
92	15	10	11	10	10	10	11	3	5	5	5	5	5	5
93	19	18	18	--	--	--	--	2	3	3	-	-	-	-
94	15	13	12	12	14	13	12	3	4	4	4	4	4	4
95	16	18	12	15	16	17	15	3	3	4	3	3	3	3
96	19	18	16	18	19	19	16	2	3	3	3	2	2	3
97	13	13	12	10	12	11	12	4	4	4	5	4	5	4
98	12	13	12	13	15	17	15	4	4	4	4	3	3	3
99	15	16	13	15	15	16	15	3	3	4	3	3	3	3
100	16	16	15	14	14	14	10	3	3	3	4	4	4	5
101	14	13	10	--	--	--	--	4	4	5	-	-	-	-
102	19	--	--	14	16	15	14	2	-	-	4	3	3	4
103	13	--	--	11	12	13	12	4	-	-	5	4	4	4
104	18	--	--	13	15	15	14	3	-	-	4	3	3	4
105	21	--	--	17	17	16	15	2	-	-	3	3	3	3

TABLE 8 (cont.)

ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
106	16	--	--	14	14	15	14	3	-	-	4	4	3	4
107	10	--	--	--	11	--	15	5	-	-	-	5	-	3
108	12	--	--	--	17	--	15	4	-	-	-	3	-	3
109	16	--	--	--	20	--	15	3	-	-	-	2	-	3
110	14	--	--	12	12	12	11	4	-	-	4	4	4	5
111	16	--	--	--	14	--	--	3	-	-	-	4	-	-
112	--	--	--	15	15	13	14	-	-	-	3	3	4	4
113	14	--	--	10	13	11	13	4	-	-	5	4	5	4
114	10	--	--	11	11	14	9	5	-	-	5	5	4	5
115	9	--	--	15	14	16	12	5	-	-	3	4	3	4
116	10	--	--	11	14	13	14	5	-	-	5	4	4	4

TABLE 9

WINTER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
1	18	17	18	20	17	17	18	3	3	3	2	3	3	3
2	17	17	14	17	17	17	17	3	3	4	3	3	3	3
3	14	15	17	17	18	18	17	4	3	3	3	3	3	3
4	17	17	15	17	15	15	17	3	3	3	3	3	3	3
5	15	15	14	13	16	18	15	3	3	4	4	3	3	3
6	18	19	16	19	19	23*	19	3	2	3	2	2	2*	2
7	17	18	15	17	16	22*	18	3	3	3	3	3	2*	3
8	11	12	10	13	14	13	11	5	4	5	4	4	4	5
9	12	13	14	13	15	14	14	4	4	4	4	3	4	4
10	17	17	17	18	17	18	17	3	3	3	3	3	3	3
11	12	12	12	13	12	13	13	4	4	4	4	4	4	4
12	11	11	11	11	12	14	13	5	5	5	5	4	4	4
13	10	12	12	10	13	13	11	5	4	4	5	4	4	5
14	12	13	13	14	15	15	15	4	4	4	4	3	3	3
15	18	16	16	17	17	17	15	3	3	3	3	3	3	3
16	10	12	11	11	13	13	12	5	4	5	5	4	4	4
17	14	17	14	16	17	17	15	4	3	4	3	3	3	3
18	16	18	15	18	19	18	18	3	3	3	3	2	3	3
19	15	16	15	16	16	17	16	3	3	3	3	3	3	3
20	19	21	20	23*	23*	21	23*	2	2	2	2*	2*	2	2*
21	9	10	9	9	10	11	10	5	5	5	5	5	5	5
22	12	11	11	11	15	13	12	4	5	5	5	3	4	4
23	14	13	13	14	16	18	14	4	4	4	4	3	3	4
24	8	8	8	9	10	11	10	5	5	5	5	5	5	5
25	11	13	11	14	14	14	14	5	4	5	4	4	4	4
26	16	14	13	13	14	13	13	3	4	4	4	4	4	4
27	11	17	10	14	14	14	13	5	3	5	4	4	4	4
28	11	9	8	10	11	12	11	5	5	5	5	5	4	5
29	11	13	10	14	14	15	13	5	4	5	4	4	3	4
30	14	12	11	9	11	14	11	4	4	5	5	5	4	5
31	11	13	10	12	13	13	12	5	4	5	4	4	4	4
32	11	11	11	13	13	13	11	5	5	5	4	4	4	5
33	8	16	14	15	15	17	14	5	3	4	3	3	3	4
34	10	13	14	11	14	15	15	5	4	4	5	4	3	3
35	9	17	14	12	14	15	15	5	3	4	4	4	3	3

TABLE 9 (cont.)

WINTER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
36	9	8	9	9	10	9	9	5	5	5	5	5	5	5
37	10	11	10	14	14	14	13	5	5	5	4	4	4	4
38	8	10	8	8	9	10	10	5	5	5	5	5	5	5
39	11	11	9	10	9	12	12	5	5	5	5	5	4	4
40	17	14	14	14	17	18	17	3	4	4	4	3	3	3
41	10	11	10	12	12	14	13	5	5	5	4	4	4	4
42	9	8	8	11	9	11	10	5	5	5	5	5	5	5
43	9	14	11	17	18	17	15	5	4	5	3	3	3	3
44	8	9	8	10	10	10	9	5	5	5	5	5	5	5
45	8	9	9	10	10	14	11	5	5	5	5	5	4	5
46	8	8	8	9	9	10	8	5	5	5	5	5	5	5
47	13	15	14	14	12	14	14	4	3	4	4	4	4	4
48	10	10	9	11	11	12	11	5	5	5	5	5	4	5
49	18	17	14	17	21	23*	18	3	3	4	3	2	2*	3
50	11	12	10	11	13	12	11	5	4	5	5	4	4	5
51	12	12	11	12	13	14	13	4	4	5	4	4	4	4
52	11	11	12	11	12	13	12	5	5	4	5	4	4	4
53	9	9	8	8	10	10	10	5	5	5	5	5	5	5
54	9	10	9	9	10	11	10	5	5	5	5	5	5	5
55	10	10	9	12	12	12	12	5	5	5	4	4	4	4
56	15	15	14	14	15	16	15	3	3	4	4	3	3	3
57	18	22*	15	23*	22*	24*	23*	3	2*	3	2*	2*	2*	2*
58	16	13	11	14	13	13	14	3	4	5	4	4	4	4
59	13	11	10	12	11	12	12	4	5	5	4	5	4	4
60	9	9	8	10	11	11	10	5	5	5	5	5	5	5
61	8	10	8	12	12	9	9	5	5	5	4	4	5	5
62	10	9	9	14	17	18	16	5	5	5	4	3	3	3
63	16	18	15	19	18	23*	18	3	3	3	2	3	2*	3
64	11	11	9	14	13	16	14	5	5	5	4	4	3	4
65	17	14	15	15	15	16	13	3	4	3	3	3	3	4
66	12	14	13	13	13	14	12	4	4	4	4	4	4	4
67	13	11	10	11	16	11	12	4	5	5	5	3	5	4
68	11	12	11	12	14	14	12	5	4	5	4	4	4	4
69	16	11	11	11	11	15	14	3	5	5	5	5	3	4
70	13	8	10	11	11	13	14	4	5	5	5	5	4	4

TABLE 9 (cont.)

WINTER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATION OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
71	11	8	10	13	11	14	14	5	5	5	4	5	4	4
72	14	13	10	15	15	18	17	4	4	5	3	3	3	3
73	10	10	13	12	12	15	12	5	5	4	4	4	3	4
74	12	15	13	12	14	15	11	4	3	4	4	4	3	5
75	18	18	--	17	18	17	18	3	3	-	3	3	3	3
76	18	22+	17	16	18	17	18	3	2+	3	3	3	3	3
77	22+	17	18	23+	23+	17	18	2+	3	3	2+	2+	3	3
78	22+	22+	18	18	23+	23+	19	2+	2+	3	3	2+	2+	2
79	14	17	14	14	16	16	15	4	3	4	4	3	3	3
80	18	20	17	--	14	--	15	3	2	3	-	4	-	3
81	18	16	15	12	15	18	18	3	3	3	4	3	3	3
82	21	15	16	15	19	19	20	2	3	3	3	2	2	2
83	18	13	12	13	14	14	13	3	4	4	4	4	4	4
84	21	17	16	16	18	17	17	2	3	3	3	3	3	3
85	14	13	12	11	11	14	12	4	4	4	5	5	4	4
86	17	14	15	10	14	10	13	3	4	3	5	4	5	4
87	14	15	--	13	13	13	11	4	3	-	4	4	4	5
88	14	11	--	13	14	15	13	4	5	-	4	4	3	4
89	14	13	14	12	15	17	16	4	4	4	4	3	3	3
90	15	12	12	12	15	14	14	3	4	4	4	3	4	4
91	12	15	12	14	17	13	17	4	3	4	4	3	4	3
92	16	10	12	10	9	10	11	3	5	4	5	5	5	5
93	21	20	20	--	--	--	--	2	3	2	-	-	-	-
94	17	14	13	13	15	14	14	3	4	4	4	3	4	4
95	17	20	14	17	18	18	17	3	2	4	3	3	3	3
96	20	19	17	20	20	20	18	2	2	3	2	2	2	3
97	14	14	13	11	13	11	13	4	4	4	5	4	5	4
98	13	14	13	14	17	18	17	4	4	4	4	3	3	3
99	17	18	15	17	17	17	17	3	3	3	3	3	3	3
100	17	17	16	15	15	14	11	3	3	3	3	3	4	5
101	14	13	10	--	--	--	--	4	4	5	-	-	-	-
102	20	--	--	15	16	16	15	2	-	-	3	3	3	3
103	13	--	--	11	12	13	12	4	-	-	5	4	4	4
104	19	--	--	13	15	16	15	2	-	-	4	3	3	3
105	23+	--	--	19	19	18	16	2+	-	-	2	2	3	3

TABLE 9 (cont.)

WINTER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
106	17	--	--	15	14	16	14	3	-	-	3	4	3	4
107	11	--	--	--	11	--	16	5	-	-	-	5	-	3
108	13	--	--	--	19	--	16	4	-	-	-	3	-	3
109	18	--	--	--	22+	--	17	3	-	-	-	2+	-	3
110	15	--	--	13	13	13	12	3	-	-	4	4	4	4
111	18	--	--	--	14	--	--	3	-	-	-	4	-	-
112	--	--	--	16	17	14	15	-	-	-	3	3	4	3
113	15	--	--	10	13	12	14	3	-	-	5	4	4	4
114	11	--	--	11	11	14	10	5	-	-	5	5	4	5
115	10	--	--	16	15	16	13	5	-	-	3	3	3	4
116	11	--	--	12	15	14	15	5	-	-	4	3	4	3

TABLE 10

SPRING EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
1	17	16	16	19	17	16	17	3	3	3	2	3	3	3
2	16	16	13	16	16	16	16	3	3	3	3	3	3	3
3	14	14	15	16	17	17	16	4	4	3	3	3	3	3
4	16	16	14	16	15	15	16	3	3	4	3	3	3	3
5	15	14	12	13	15	17	15	3	4	4	4	3	3	3
6	17	17	15	18	18	21	18	3	3	3	3	3	2	3
7	15	16	14	15	15	20	17	3	3	4	3	3	2	3
8	10	12	10	13	15	14	12	5	4	5	4	3	4	4
9	12	12	13	13	15	13	13	4	4	4	4	3	4	4
10	15	15	15	16	16	17	16	3	3	3	3	3	3	3
11	12	11	10	12	11	13	12	4	5	5	4	5	4	4
12	10	10	10	11	12	13	13	5	5	5	5	4	4	4
13	10	12	12	11	14	14	12	5	4	4	5	4	4	4
14	12	13	13	15	15	15	14	4	4	4	3	3	3	4
15	16	16	15	16	16	16	15	3	3	3	3	3	3	3
16	10	11	10	11	14	14	12	5	5	5	5	4	4	4
17	15	18	14	18	18	18	15	3	3	4	3	3	3	3
18	17	18	14	19	20	19	19	3	3	4	2	2	2	2
19	15	15	14	16	16	17	16	3	3	4	3	3	3	3
20	18	20	18	21	22+	20	22+	3	2	3	2	2+	2	2+
21	9	9	9	8	10	11	10	5	5	5	5	5	5	5
22	11	10	10	11	14	13	12	5	5	5	5	4	4	4
23	13	12	12	14	15	18	14	4	4	4	4	3	3	4
24	8	7	7	9	11	12	11	5	5	5	5	5	4	5
25	10	11	10	13	13	13	14	5	5	5	4	4	4	4
26	15	13	12	12	14	13	13	3	4	4	4	4	4	4
27	10	15	9	13	13	13	12	5	3	5	4	4	4	4
28	11	8	8	10	12	14	11	5	5	5	5	4	4	5
29	11	12	9	13	13	14	12	5	4	5	4	4	4	4
30	14	12	11	10	11	15	11	4	4	5	5	5	3	5
31	11	12	9	12	14	14	12	5	4	5	4	4	4	4
32	11	10	11	14	14	14	11	5	5	5	4	4	4	5
33	8	14	12	14	14	15	13	5	4	4	4	4	3	4
34	10	11	12	10	13	15	14	5	5	4	5	4	3	4
35	10	15	12	12	14	15	14	5	3	4	4	4	3	4

TABLE 10 (cont.)

SPRING EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
36	9	8	9	9	11	10	9	5	5	5	5	5	5	5
37	11	10	9	14	13	14	12	5	5	5	4	4	4	4
38	7	9	7	7	9	11	9	5	5	5	5	5	5	5
39	11	10	8	10	9	11	11	5	5	5	5	5	5	5
40	15	13	13	13	16	16	16	3	4	4	4	3	3	3
41	10	10	10	11	12	14	12	5	5	5	5	5	4	4
42	9	7	7	10	9	11	9	5	5	5	5	5	5	5
43	9	13	10	16	16	16	14	5	4	5	3	3	3	4
44	9	8	8	10	11	10	9	5	5	5	5	5	5	5
45	9	8	8	9	10	13	10	5	5	5	5	5	4	5
46	7	8	7	9	9	10	8	5	5	5	5	5	5	5
47	12	13	13	14	12	13	13	4	4	4	4	4	4	4
48	10	9	9	11	11	12	11	5	5	5	5	5	5	5
49	16	15	12	16	20	20	16	3	3	4	3	3	2	3
50	12	11	9	11	13	13	11	4	5	5	5	5	4	5
51	13	11	11	12	13	13	13	4	5	5	4	4	4	4
52	11	10	11	10	13	14	11	5	5	5	5	5	4	5
53	9	8	8	8	11	11	11	5	5	5	5	5	5	5
54	9	10	8	9	10	11	9	5	5	5	5	5	5	5
55	10	10	8	12	13	12	12	5	5	5	4	4	4	4
56	15	14	13	13	15	17	15	3	4	4	4	4	3	3
57	17	20	14	21	21	22+	21	3	2	4	2	2	2+	2
58	15	12	11	14	13	13	14	3	4	5	4	4	4	4
59	11	10	9	12	11	12	12	5	5	5	4	4	4	4
60	8	8	8	10	12	12	10	5	5	5	5	5	4	5
61	8	10	8	12	13	10	10	5	5	5	4	4	5	5
62	9	8	8	15	19	17	16	5	5	5	3	2	3	3
63	17	18	14	20	18	21	18	3	3	4	2	3	2	3
64	12	11	8	14	13	17	14	4	5	5	4	4	3	4
65	16	14	14	14	14	16	12	3	4	4	4	4	3	4
66	12	13	11	12	12	13	12	4	4	5	4	4	4	4
67	13	11	9	10	16	12	12	4	5	5	5	3	4	4
68	10	11	10	12	14	14	13	5	5	5	4	4	4	4
69	15	10	10	10	10	15	13	3	5	5	5	5	3	4
70	12	7	9	11	11	14	13	4	5	5	5	5	4	4

TABLE 10 (cont.)

SPRING EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
71	10	8	9	12	11	13	13	5	5	5	4	5	4	4
72	13	12	9	14	15	17	15	4	4	5	4	3	3	3
73	10	9	12	12	12	15	11	5	5	4	4	4	3	5
74	12	15	13	12	14	17	12	4	3	4	4	4	3	4
75	17	16	--	15	17	16	17	3	3	-	3	3	3	3
76	16	20	15	15	17	15	16	3	2	3	3	3	3	3
77	20	16	16	22+	22+	16	17	2	3	3	2+	2+	3	3
78	20	20	16	17	20	22+	19	2	2	3	3	2+	2*	2
79	14	15	12	14	15	16	15	4	3	4	4	3	3	3
80	17	18	15	--	15	--	15	3	3	3	-	3	-	3
81	17	15	13	12	15	17	17	3	3	4	4	3	3	3
82	22+	15	15	15	21	19	20	2+	3	3	3	2	2	2
83	16	11	11	12	13	15	12	3	5	5	4	4	3	4
84	22+	16	15	15	17	17	17	2+	3	3	3	3	3	3
85	15	13	11	12	11	16	13	3	4	5	4	5	3	4
86	18	13	14	10	14	11	12	3	4	4	5	4	5	4
87	14	14	--	13	13	13	11	4	4	-	4	4	4	5
88	13	10	--	12	13	14	12	4	5	-	4	4	4	4
89	14	12	13	11	14	16	15	4	4	4	5	4	3	3
90	15	12	11	12	15	14	13	3	4	5	4	3	4	4
91	12	13	11	14	16	13	15	4	4	5	4	3	4	3
92	15	10	11	10	10	11	11	3	5	5	5	5	5	5
93	20	18	18	--	--	--	--	2	3	3	-	-	-	-
94	16	13	12	13	14	13	13	3	4	4	4	4	4	4
95	16	18	12	16	17	17	16	3	3	4	3	3	3	3
96	19	18	16	19	20	19	17	2	3	3	2	2	2	3
97	14	13	12	11	13	11	13	4	4	4	5	4	5	4
98	12	13	12	13	16	17	15	4	4	4	4	3	3	3
99	16	16	13	16	16	16	16	3	3	4	3	3	3	3
100	17	16	15	14	15	15	11	3	3	3	4	3	3	5
101	15	13	10	--	--	--	--	3	4	5	-	-	-	-
102	21	--	--	15	17	16	14	2	-	-	3	3	3	4
103	14	--	--	12	12	14	12	4	-	-	4	4	4	4
104	19	--	--	14	16	16	14	2	-	-	4	3	3	4
105	22+	--	--	18	18	17	16	2+	-	-	3	3	3	3

TABLE 10 (cont.)

SPRING EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
106	17	--	--	15	15	16	15	3	-	-	3	3	3	3
107	11	--	--	--	11	--	15	5	-	-	-	5	-	3
108	13	--	--	--	18	--	15	4	-	-	-	3	-	3
109	17	--	--	--	21	--	15	3	-	-	-	2	-	3
110	15	--	--	12	13	12	12	3	-	-	4	4	4	4
111	17	--	--	--	14	--	--	3	-	-	-	4	-	-
112	--	--	--	15	16	14	14	-	-	-	3	3	4	4
113	16	--	--	10	14	11	14	3	-	-	5	4	5	4
114	11	--	--	12	11	15	10	5	-	-	4	5	3	5
115	9	--	--	16	15	17	12	5	-	-	3	3	3	4
116	11	--	--	11	15	13	14	5	-	-	5	3	4	4

TABLE 11

SUMMER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
1	13	16	16	15	13	13	14	4	3	3	3	4	4	4
2	12	16	13	12	12	12	13	4	3	3	4	4	4	4
3	10	14	15	13	13	13	13	5	4	3	4	4	4	4
4	13	16	14	13	11	11	12	4	3	4	4	5	5	4
5	13	14	12	11	12	13	12	4	4	4	5	4	4	4
6	13	17	15	14	13	16	13	4	3	3	4	4	3	4
7	12	16	14	12	11	15	13	4	3	4	4	5	3	4
8	8	12	10	11	13	12	10	5	4	5	5	4	4	5
9	9	12	13	10	11	10	10	5	4	4	5	5	5	5
10	11	15	15	12	12	13	12	5	3	3	4	4	4	4
11	9	11	10	9	8	10	10	5	5	5	5	5	5	5
12	8	10	10	8	10	10	10	5	5	5	5	5	5	5
13	9	12	12	9	12	12	10	5	4	4	5	5	4	5
14	10	13	13	13	13	13	12	5	4	4	4	4	4	4
15	13	16	15	12	12	12	11	4	3	3	4	4	4	5
16	8	11	10	9	12	12	10	5	5	5	5	4	4	5
17	12	18	14	16	16	16	13	4	3	4	4	3	3	4
18	13	18	14	16	17	16	16	4	3	4	4	3	3	3
19	11	15	14	13	13	13	13	5	3	4	4	4	4	4
20	15	20	18	26	18	16	17	3	2	3	3	3	3	3
21	7	9	9	7	7	9	8	5	5	5	5	5	5	5
22	9	10	10	8	11	11	9	5	5	5	5	5	5	5
23	10	12	12	11	12	16	12	5	4	4	5	5	3	4
24	6	7	7	8	9	10	9	5	5	5	5	5	5	5
25	8	11	10	10	10	10	10	5	5	5	4	5	5	5
26	12	13	12	10	11	11	10	4	4	4	5	5	5	5
27	8	15	9	10	10	10	10	5	3	5	5	5	5	5
28	10	8	8	9	10	12	10	5	5	5	5	5	4	5
29	8	12	9	10	10	10	9	5	4	5	5	5	5	5
30	10	12	11	8	8	11	8	5	4	5	5	5	5	5
31	8	12	9	9	10	10	9	5	4	5	5	5	5	5
32	10	10	11	12	12	12	10	5	5	5	4	4	4	5
33	7	14	12	11	11	11	10	5	4	4	5	5	5	5
34	8	11	12	8	10	11	11	5	5	4	5	5	5	5
35	7	15	12	9	10	12	11	5	3	4	5	5	4	5

TABLE 11 (cont.)

SUMMER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
36	7	8	9	8	9	8	8	5	5	5	5	5	5	5
37	8	10	9	11	10	10	9	5	5	5	5	5	5	5
38	6	9	7	6	7	8	7	5	5	5	5	5	5	5
39	8	10	8	8	7	9	9	5	5	5	5	5	5	5
40	12	13	13	11	13	13	13	4	4	4	5	4	4	4
41	8	10	10	9	9	10	9	5	5	5	5	5	5	5
42	7	7	7	8	7	9	7	5	5	5	5	5	5	5
43	7	13	10	12	13	12	11	5	4	5	4	4	4	5
44	7	8	8	9	9	8	8	5	5	5	5	5	5	5
45	6	8	8	7	8	10	8	5	5	5	5	5	5	5
46	6	8	7	8	7	9	6	5	5	5	5	5	5	5
47	9	13	13	10	9	10	10	5	4	4	5	5	5	5
48	7	9	9	8	8	9	8	5	5	5	5	5	5	5
49	12	15	12	12	15	15	13	4	3	4	4	3	3	4
50	9	11	9	9	10	10	8	5	5	5	5	5	5	5
51	9	11	11	9	9	10	10	5	5	5	5	5	5	5
52	8	10	11	7	9	9	8	5	5	5	5	5	5	5
53	6	8	8	6	7	7	7	5	5	5	5	5	5	5
54	8	10	8	7	8	9	7	5	5	5	5	5	5	5
55	9	10	8	10	10	9	10	5	5	5	5	5	5	5
56	13	14	13	10	12	15	12	4	4	4	5	4	3	4
57	13	20	14	16	16	17	17	4	2	4	3	3	3	3
58	12	12	11	11	11	10	12	4	4	5	5	5	5	4
59	9	10	9	9	8	10	9	5	5	5	5	5	5	5
60	7	8	8	8	9	9	8	5	5	5	5	5	5	5
61	6	10	8	10	10	8	8	5	5	5	5	5	5	5
62	7	8	8	13	16	16	13	5	5	5	5	3	3	4
63	13	18	14	16	14	16	14	4	3	4	3	4	3	4
64	9	11	8	11	10	13	11	5	5	5	5	5	4	5
65	12	14	14	11	12	13	9	4	4	4	5	4	4	5
66	9	13	11	9	9	10	10	5	4	5	5	5	5	5
67	11	11	9	8	12	10	10	5	5	5	5	4	5	5
68	8	11	10	9	12	11	10	5	5	5	5	4	5	5
69	11	10	10	8	8	11	10	5	5	5	5	5	5	5
70	9	7	9	9	9	11	10	5	5	5	5	5	5	5

TABLE 11 (cont.)

SUMMER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATION OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
71	7	8	9	9	8	10	10	5	5	5	5	5	5	5
72	10	12	9	11	11	13	11	5	4	5	5	5	4	5
73	8	9	12	9	9	12	10	5	5	4	5	5	4	5
74	9	15	13	10	12	13	9	5	3	4	5	4	4	5
75	13	16	--	11	13	13	13	4	3	-	5	4	4	4
76	12	20	15	11	13	12	13	4	2	3	3	4	4	4
77	15	16	16	16	17	12	13	3	3	3	3	3	4	4
78	15	20	16	12	16	16	14	3	2	3	4	3	3	4
79	10	15	12	11	12	13	12	5	3	4	5	4	4	4
80	13	18	15	--	13	--	13	4	3	3	-	4	-	4
81	12	15	13	10	13	14	14	4	3	4	5	4	4	4
82	15	15	15	11	14	14	15	3	3	3	5	4	4	3
83	12	11	11	10	10	12	9	4	5	5	5	5	4	5
84	17	16	15	12	13	12	13	3	3	3	4	4	4	4
85	11	13	11	9	8	11	10	5	4	5	5	5	5	5
86	13	13	14	7	10	7	9	4	4	4	5	5	5	5
87	10	14	--	10	10	10	8	5	4	-	5	5	5	5
88	10	10	--	9	10	11	10	5	5	-	5	5	5	5
89	10	12	13	9	11	12	11	5	4	4	5	5	4	5
90	13	12	11	10	12	12	10	4	4	5	5	4	4	5
91	9	13	11	10	12	10	12	5	4	5	5	4	5	4
92	12	10	11	9	9	9	10	4	5	5	5	5	5	5
93	16	18	18	--	--	--	--	3	3	3	-	-	-	-
94	12	13	12	10	12	11	10	4	4	4	5	4	5	5
95	13	18	12	12	13	14	12	4	3	4	4	4	4	4
96	15	18	16	14	15	16	13	3	3	3	4	3	3	4
97	11	13	12	9	10	9	10	5	4	4	5	5	5	5
98	9	13	12	10	12	13	11	5	4	4	5	4	4	5
99	12	16	13	12	12	12	12	4	3	4	4	4	4	4
100	13	16	15	11	11	11	8	4	3	3	5	5	5	5
101	13	13	10	--	--	--	--	4	4	5	-	-	-	-
102	17	--	--	12	13	13	11	3	-	-	4	4	4	5
103	12	--	--	10	10	12	10	4	-	-	5	5	4	5
104	15	--	--	11	13	13	11	3	-	-	5	4	4	5
105	17	--	--	15	14	14	12	3	-	-	3	4	4	4

TABLE 11 (cont.)

SUMMER EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
106	14	--	--	11	12	14	12	4	-	-	5	4	4	4
107	8	--	--	--	9	--	13	5	-	-	-	5	-	4
108	10	--	--	--	13	--	12	5	-	-	-	4	-	4
109	13	--	--	--	15	--	11	4	-	-	-	3	-	5
110	11	--	--	9	10	9	9	5	-	-	5	5	5	5
111	13	--	--	--	12	--	--	4	-	-	-	4	-	-
112	--	--	--	12	12	11	11	-	-	-	4	4	5	5
113	12	--	--	8	10	9	11	4	-	-	5	5	5	5
114	9	--	--	10	10	13	8	5	-	-	5	5	4	5
115	7	--	--	12	11	13	9	5	-	-	4	5	4	5
116	8	--	--	9	11	10	11	5	-	-	5	5	5	5

TABLE 12

FALL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STATION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
1	15	16	16	16	15	15	15	3	3	3	3	3	3	3
2	14	16	13	14	14	14	14	4	3	3	4	4	4	4
3	13	14	15	14	15	15	14	4	4	3	4	3	3	4
4	15	16	14	14	13	13	14	3	3	4	4	4	4	4
5	13	14	12	12	13	15	13	4	4	4	4	4	3	4
6	15	17	15	16	16	19	16	3	3	3	3	3	2	3
7	13	16	14	13	13	18	15	4	3	4	4	4	3	3
8	10	12	10	12	14	13	11	5	4	5	4	4	4	5
9	11	12	13	11	13	12	12	5	4	4	5	4	4	4
10	13	15	15	14	14	15	14	4	3	3	4	4	3	4
11	11	11	10	11	10	12	12	5	5	5	5	5	4	4
12	9	10	10	10	11	12	12	5	5	5	5	5	4	4
13	9	12	12	10	12	12	11	5	4	4	5	4	4	5
14	11	13	13	14	14	14	14	5	4	4	4	4	4	4
15	15	16	15	14	15	15	14	3	3	3	4	3	3	4
16	9	11	10	10	13	13	11	5	5	5	5	4	4	5
17	13	18	14	16	16	17	14	4	3	4	3	3	3	4
18	16	18	14	17	18	18	18	3	3	4	3	3	3	3
19	14	15	14	15	15	16	16	4	3	4	3	3	3	3
20	17	20	18	19	20	19	20	3	2	3	2	2	2	2
21	8	9	9	8	9	11	9	5	5	5	5	5	5	5
22	10	10	10	10	12	12	10	5	5	5	5	4	4	5
23	11	12	12	12	13	17	13	5	4	4	4	4	3	4
24	7	7	7	9	10	11	9	5	5	5	5	5	5	5
25	9	11	10	12	12	12	13	5	5	5	4	4	4	4
26	13	13	12	11	12	12	11	4	4	4	5	4	4	5
27	9	15	9	12	12	12	11	5	3	5	4	4	4	5
28	11	8	8	9	11	12	11	5	5	5	5	5	4	5
29	10	12	9	12	12	13	11	5	4	5	4	4	4	5
30	13	12	11	9	11	15	11	4	4	5	5	5	3	5
31	11	12	9	12	13	13	11	5	4	5	4	4	4	5
32	11	10	11	12	12	12	11	5	5	5	4	4	4	5
33	8	14	12	14	14	13	12	5	4	4	4	4	4	4
34	9	11	12	10	12	14	13	5	5	4	5	4	4	4
35	9	15	12	11	12	14	13	5	3	4	5	4	4	4

TABLE 12 (cont.)

FALL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
36	9	8	9	9	10	9	8	5	5	5	5	5	5	5
37	10	10	9	13	12	13	12	5	5	5	4	4	4	4
38	7	9	7	7	8	10	8	5	5	5	5	5	5	5
39	10	10	8	9	9	11	11	5	5	5	5	5	5	5
40	13	13	13	12	14	14	15	4	4	4	4	4	4	3
41	9	10	10	11	12	13	12	5	5	5	5	4	4	4
42	8	7	7	9	8	10	8	5	5	5	5	5	5	5
43	8	13	10	14	15	14	13	5	4	5	4	3	4	4
44	8	8	8	9	9	9	8	5	5	5	5	5	5	5
45	8	8	8	9	10	11	9	5	5	5	5	5	5	5
46	7	8	7	8	8	9	7	5	5	5	5	5	5	5
47	11	13	13	13	11	13	12	5	4	4	4	5	4	4
48	9	9	9	11	10	11	10	5	5	5	5	5	5	5
49	14	15	12	14	17	18	14	4	3	4	4	3	3	4
50	10	11	9	9	11	11	10	5	5	5	5	5	5	5
51	13	11	11	12	13	12	13	4	5	5	4	4	4	4
52	10	10	11	9	12	13	10	5	5	5	5	4	4	5
53	9	8	8	8	10	10	10	5	5	5	5	5	5	5
54	8	10	8	8	9	10	9	5	5	5	5	5	5	5
55	10	10	8	10	11	10	11	5	5	5	5	4	5	5
56	14	14	13	12	13	15	13	4	4	4	4	4	3	4
57	15	20	14	19	18	20	20	3	2	4	2	3	2	2
58	14	12	11	13	12	12	13	4	4	5	4	4	4	4
59	10	10	9	10	9	11	11	5	5	5	5	5	5	5
60	8	8	8	9	10	10	9	5	5	5	5	5	5	5
61	7	10	8	11	11	9	9	5	5	5	5	5	5	5
62	8	8	8	14	17	17	14	5	5	5	4	3	3	4
63	16	18	14	18	18	20	17	3	3	4	3	3	2	3
64	11	11	8	13	12	16	13	5	5	5	4	4	3	4
65	14	14	14	13	14	15	11	4	4	4	4	4	3	5
66	10	13	11	11	10	12	11	5	4	5	5	5	4	5
67	12	11	9	9	15	11	11	4	5	5	5	3	5	5
68	10	11	10	12	13	14	12	5	5	5	4	4	4	4
69	13	10	10	10	9	13	12	4	5	5	5	5	4	4
70	10	7	9	10	10	12	11	5	5	5	5	5	4	5

TABLE 12 (cont.)

FALL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATION OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION NO.	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
71	9	8	9	10	9	11	11	5	5	5	5	5	5	5
72	12	12	9	13	13	15	13	4	4	5	4	4	3	4
73	9	9	12	10	10	14	11	5	5	4	5	5	4	5
74	12	15	13	12	14	15	10	4	3	4	4	4	3	5
75	15	16	--	13	15	14	15	3	3	-	4	3	4	3
76	14	20	15	13	15	14	15	4	2	3	4	3	4	3
77	18	16	16	19	19	15	15	3	3	3	2	2	3	3
78	18	20	16	16	18	20	18	3	2	3	3	3	2	3
79	13	15	12	13	14	14	13	4	3	4	4	4	4	4
80	15	18	15	--	14	--	14	3	3	3	-	4	-	4
81	16	15	13	12	15	15	16	3	3	4	4	3	3	3
82	21	15	15	14	20	19	21	2	3	3	4	2	2	2
83	14	11	11	11	12	13	11	4	5	5	5	4	4	5
84	20	16	15	15	16	16	16	2	3	3	3	3	3	3
85	14	13	11	11	10	14	12	4	4	5	5	5	4	4
86	17	13	14	9	12	10	11	3	4	4	5	4	5	5
87	13	14	--	12	11	12	10	4	4	-	4	5	4	5
88	12	10	--	12	12	14	12	4	5	-	4	4	4	4
89	12	12	13	11	14	15	13	4	4	4	5	4	3	4
90	14	12	11	11	14	13	12	4	4	5	5	4	4	4
91	12	13	11	13	14	12	14	4	4	5	4	4	4	4
92	14	10	11	9	9	10	11	4	5	5	5	5	5	5
93	17	18	18	--	--	--	--	3	3	3	-	-	-	-
94	14	13	12	12	14	12	11	4	4	4	4	4	4	5
95	16	18	12	14	15	16	14	3	3	4	4	3	3	4
96	18	18	16	17	17	19	16	3	3	3	3	3	2	3
97	13	13	12	10	12	10	12	4	4	4	5	4	5	4
98	11	13	12	12	14	17	14	5	4	4	4	4	3	4
99	14	16	13	14	14	15	14	4	3	4	4	4	3	4
100	16	16	15	14	14	14	10	3	3	3	4	4	4	5
101	14	13	10	--	--	--	--	4	4	5	-	-	-	-
102	19	--	--	13	15	15	13	2	-	-	4	3	3	4
103	12	--	--	10	11	13	12	4	-	-	5	5	4	4
104	17	--	--	12	14	15	14	3	-	-	4	4	3	4
105	19	--	--	16	16	16	15	2	-	-	3	3	3	3

TABLE 12 (cont.)

FALL EQUIVALENT AVERAGE VELOCITIES (mph) AND MELBORNE CATEGORIES FOR ALL CONFIGURATIONS OF THE PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STA-TION	EQUIVALENT AVERAGE CONFIGURATION							MELBOURNE CATEGORY CONFIGURATION						
NO.	EX	BD	BD2	A	C	A2	C2	EX	BD	B2	A	C	A2	C2
106	16	--	--	14	13	15	13	3	-	-	4	4	3	4
107	10	--	--	--	10	--	14	5	-	-	-	5	-	4
108	12	--	--	--	17	--	15	4	-	-	-	3	-	3
109	15	--	--	--	19	--	14	3	-	-	-	2	-	4
110	14	--	--	11	12	12	11	4	-	-	5	4	4	5
111	16	--	--	--	13	--	--	3	-	-	-	4	-	-
112	--	--	--	14	14	13	13	-	-	-	4	4	4	4
113	14	--	--	10	12	11	13	4	-	-	5	4	5	4
114	11	--	--	11	11	14	9	5	-	-	5	5	4	5
115	9	--	--	14	13	15	11	5	-	-	4	4	3	5
116	9	--	--	11	14	12	14	5	-	-	5	4	4	4

TABLE 13

CHANGES IN ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph)
FROM THE EXISTING CONFIGURATION TO THE SIX PROPOSED CONFIGURATIONS
OF PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STATION NO.	CONFIGURATION BD	BD2	A	C	A2	C2
1	0	0	+2	0	0	+1
2	+1	-2	+1	+1	+1	+1
3	+1	+2	+3	+3	+3	+3
4	0	-2	0	-2	-2	0
5	0	-2	-1	0	+2	0
6	+1	-1	+1	+1	+4	+1
7	+1	-1	0	-1	+5	+1
8	+2	0	+3	+4	+3	+1
9	+1	+2	+1	+3	+1	+2
10	0	0	0	+1	+2	+1
11	0	-1	0	0	+1	+1
12	0	0	0	+1	+3	+2
13	+2	+2	0	+3	+3	+1
14	+2	+2	+3	+3	+3	+3
15	0	-1	-1	0	0	-2
16	+1	0	+1	+3	+3	+1
17	+4	0	+3	+3	+3	0
18	+2	-2	+2	+3	+2	+2
19	+1	0	+1	+1	+2	+2
20	+2	0	+3	+4	+1	+3
21	+1	+1	0	+1	+3	+2
22	-1	-1	-1	+3	+2	+1
23	-1	-1	0	+1	+4	+1
24	0	0	+2	+3	+4	+3
25	+1	0	+3	+3	+3	+3
26	-2	-3	-3	-2	-2	-3
27	+5	-1	+3	+3	+3	+2
28	-3	-3	-1	0	+2	0
29	+2	-1	+3	+3	+3	+2
30	-1	-2	-4	-3	+1	-2
31	+2	-1	+2	+3	+3	+1
32	-1	0	+2	+2	+2	0
33	+6	+4	+6	+6	+7	+5
34	+2	+3	+1	+4	+5	+5
35	+6	+3	+2	+4	+6	+5

TABLE 13 (cont.)

CHANGES IN ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph)
FROM THE EXISTING CONFIGURATION TO THE SIX PROPOSED CONFIGURATIONS
OF PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STATION NO.	CONFIGURATION BD	BD2	A	C	A2	C2
36	-1	0	0	+1	0	-1
37	0	-1	+3	+3	+3	+2
38	+2	0	0	+1	+3	+2
39	0	-2	0	-1	+1	+1
40	-2	-2	-2	+1	+1	+1
41	0	0	+1	+2	+3	+2
42	-1	-1	+2	0	+2	+1
43	+4	+1	+6	+7	+6	+5
44	0	0	+2	+2	+2	0
45	0	0	+1	+2	+3	+2
46	+1	0	+2	+1	+3	+1
47	+1	+1	+1	-1	+1	+1
48	0	0	+2	+1	+2	+1
49	-1	-4	0	+3	+4	0
50	0	-2	-1	+1	+1	-1
51	-1	-1	0	0	+1	0
52	0	+1	0	+2	+3	+1
53	-1	-1	-1	+1	+1	+1
54	+1	-1	0	0	+2	0
55	0	-2	+1	+2	+1	+2
56	0	-1	-1	0	+2	0
57	+3	-3	+3	+3	+5	+4
58	-2	-3	-1	-2	-2	-1
59	-1	-2	0	-1	+1	0
60	0	0	+1	+3	+3	+1
61	+3	+1	+4	+5	+2	+2
62	-1	-1	+5	+8	+8	+6
63	+2	-2	+3	+1	+5	+1
64	0	-3	+2	+1	+4	+2
65	-1	-1	-1	-1	0	-2
66	+2	0	+1	0	+2	0
67	-1	-3	-2	+3	-1	-1
68	+1	0	+2	+3	+3	+2
69	-5	-5	-5	-5	-1	-2
70	-4	-2	-1	-1	+2	+1

TABLE 13 (cont.)

CHANGES IN ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph)
FROM THE EXISTING CONFIGURATION TO THE SIX PROPOSED CONFIGURATIONS
OF PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STATION NO	CONFIGURATION BD	BD2	A	C	A2	C2
71	-1	0	+2	+1	+3	+3
72	-1	-4	+1	+1	+3	+2
73	0	+3	+2	+2	+5	+2
74	+3	+1	0	+2	+3	-1
75	0	--	-1	0	-1	0
76	+4	-1	-1	0	-1	0
77	-4	-4	+1	+1	-4	-3
78	0	-4	-4	0	+1	-2
79	+2	-1	0	+2	+2	+1
80	+2	-1	--	-2	--	-2
81	-2	-4	-6	-2	-1	-1
82	-5	-5	-6	-1	-2	-1
83	-5	-5	-4	-3	-2	-4
84	-4	-5	-5	-4	-4	-4
85	-1	-3	-3	-4	0	-2
86	-4	-3	-8	-4	-7	-5
87	+1	--	-1	-1	-1	-2
88	-3	--	-2	0	+1	-1
89	-1	0	-2	+1	+2	+2
90	-2	-3	-3	+1	0	-1
91	+1	-1	+1	+3	0	+3
92	-5	-4	-5	-5	-5	-4
93	-1	-1	--	--	--	--
94	-2	-3	-3	-1	-2	-3
95	+2	-4	-1	0	+1	-1
96	-1	-3	-1	0	0	-3
97	0	-1	-2	-1	-2	-1
98	+1	0	+1	+3	+4	+3
99	+1	-2	0	0	+1	0
100	0	-1	-2	-2	-2	-6
101	-1	-4	--	--	--	--
102	--	--	-5	-3	-4	-5
103	--	--	-2	-1	0	-1
104	--	--	-5	-3	-3	-4
105	--	--	-4	-4	-5	-6

TABLE 8 (cont.)

CHANGES IN ANNUAL EQUIVALENT AVERAGE VELOCITIES (mph)
FROM THE EXISTING CONFIGURATION TO THE SIX PROPOSED CONFIGURATIONS
OF PRUDENTIAL CENTER REDEVELOPMENT (EROSION TESTS)

STATION NO.	CONFIGURATION BD	BD2	A	C	A2	C2
106	--	--	-2	-2	-1	-2
107	--	--	--	-1	--	+5
108	--	--	--	+5	--	+3
109	--	--	--	+4	--	-1
110	--	--	-2	-2	-2	-3
111	--	--	--	-2	--	--
112	--	--	--	--	--	--
113	--	--	-4	-1	-3	-1
114	--	--	+1	+1	+4	-9
115	--	--	+6	+5	+7	+9
116	--	--	+1	+4	+3	+4

Table 14. Beaufort Wind Scale for Pedestrians (after Penwarden)

Beaufort Number	Description of Wind	Speed (m/sec)*	Speed (mph)*	Description of Wind Effects
0	Calm	Less than 0.4	Less than 0.9	No noticeable wind
1	Light airs	0.4 - 1.5	0.9 - 3.4	No noticeable wind
2	Light breeze	1.6 - 3.3	3.5 - 7.4	Wind felt on face
3	Gentle breeze	3.4 - 5.4	7.5 - 12.1	Wind extends light flag Hair is disturbed Clothing flaps
4	Moderate breeze	5.5 - 7.9	12.2 - 17.7	Wind raises dust, dry soil and loose paper Hair disarranged
5	Fresh breeze	8.0 - 10.7	17.8 - 23.9	Force of wind felt on body Drifting snow becomes airborne Limit of agreeable wind on land
6	Strong breeze	10.8 - 13.8	24.0 - 30.9	Umbrellas used with difficulty Hair blown straight Difficulty to walk steadily Wind noise on ears unpleasant Windborne snow above head height (blizzard)
7	Moderate gale	13.9 - 17.1	31.0 - 38.3	Inconvenience felt when walking
8	Fresh gale	17.2 - 20.7	38.4 - 46.3	Generally impedes progress Great difficulty with balance in gusts
9	Strong gale	20.8 - 24.4	46.4 - 54.6	People blown over by gusts

*Effective gusts

PHOTOS

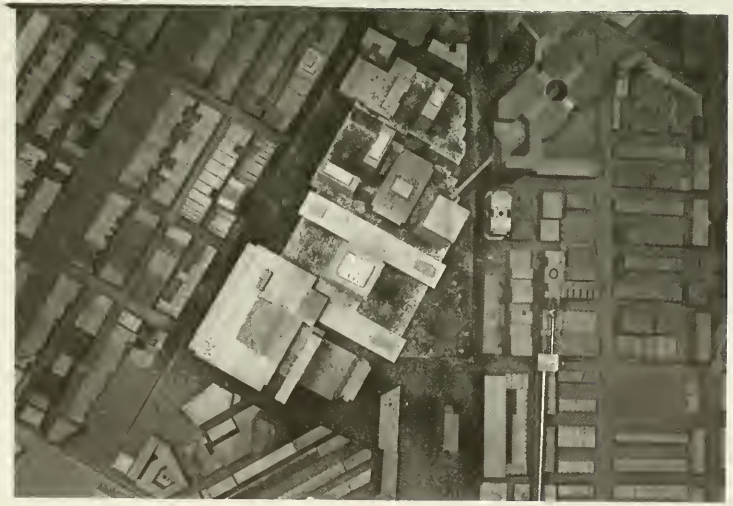
The following are photographs that were taken during the pedestrian level wind tunnel study of the Prudential Center Redevelopment. Photographs are shown for the existing configuration, Aternatives A and A2, and Alternatives C and C2. These pictures of the erosion patterns of the particles allow the winds to be qualitatively evaluated at any point originally covered by the particles.

Each set of photographs consists of seven photographs taken at 0, 10, 13, 17, 23, 30 and 40 miles per hour gradient wind velocities in the wind tunnel for winds coming from the northwest and southwest, the predominant wind directions in the Boston area.

PRUDENTIAL CENTER
REDEVELOPMENT
existing

WIND DIRECTION : NW

CAMERA 2



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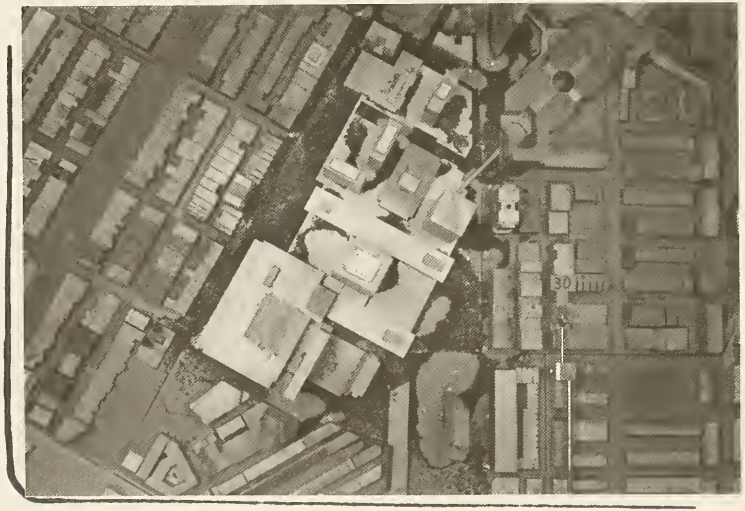

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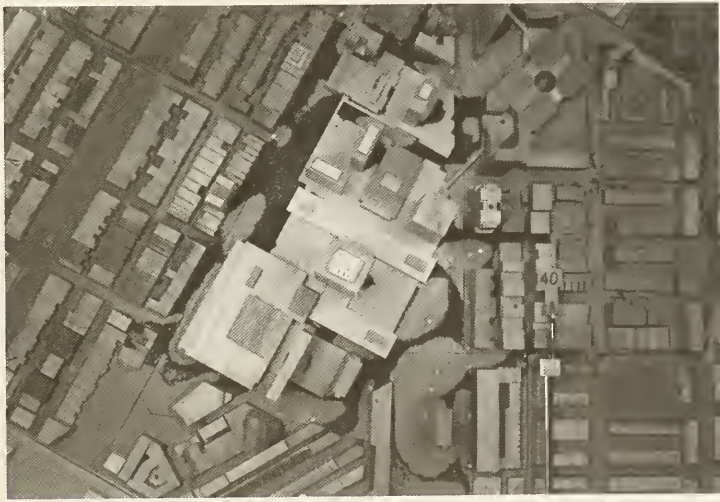

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PRUDENTIAL CENTER
REDEVELOPMENT
existing

WIND DIRECTION : SW

CAMERA 2

0

10

13

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17

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23

PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : A

WIND DIRECTION : NW

CAMERA 2

0

10

13

17

23

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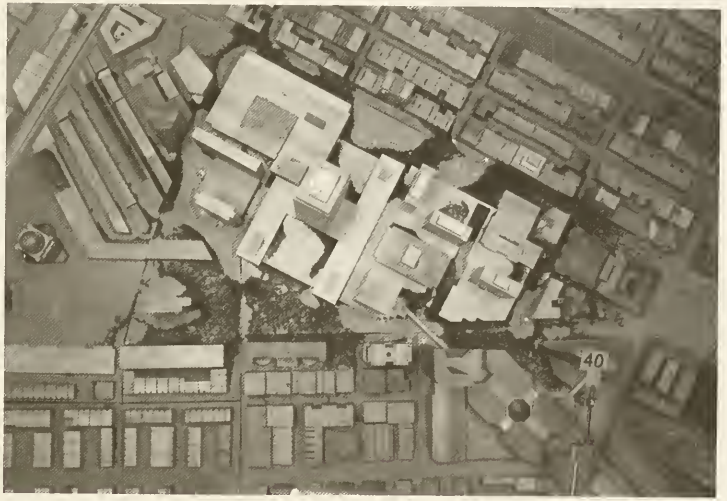

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PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : A

WIND DIRECTION : NW

CAMERA 2

0

10

13

WIND DIRECTION: NW

17

23

PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : A

WIND DIRECTION : SW

CAMERA 2

0

10

13

17

23

40

PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : A II

WIND DIRECTION : NW

CAMERA 1

0

10

13

17

23

40

PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : A II

WIND DIRECTION : SW

CAMERA 1

0

10

13

17

23

30

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PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : C

WIND DIRECTION : NW

CAMERA 2

0

10

13

WIND DIRECTION: NW

17

23

PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : C

WIND DIRECTION : SW

CAMERA 2

0

10

13

17

23

30

40

PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : C II

WIND DIRECTION : NW

CAMERA 2

0

10

13

17

23

30

40

PRUDENTIAL CENTER

REDEVELOPMENT

CONFIGURATION : C 11

WIND DIRECTION : SW

CAMERA 2

0

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